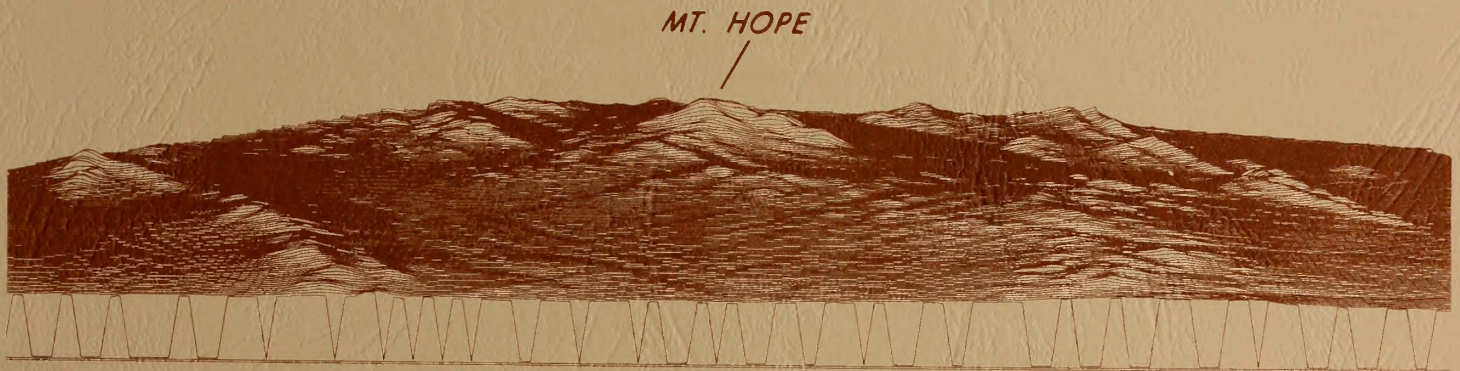


BLM LIBRARY



88009579

SOIL RESOURCES
TECHNICAL REPORT NO.5
MT. HOPE MOLYBDENUM PROJECT



View from the south looking north

U.S. DEPARTMENT OF INTERIOR
BUREAU OF LAND MANAGEMENT
BATTLE MOUNTAIN, NEVADA

DECEMBER 1984

TD
195
.M5
M686
no.5

11950669

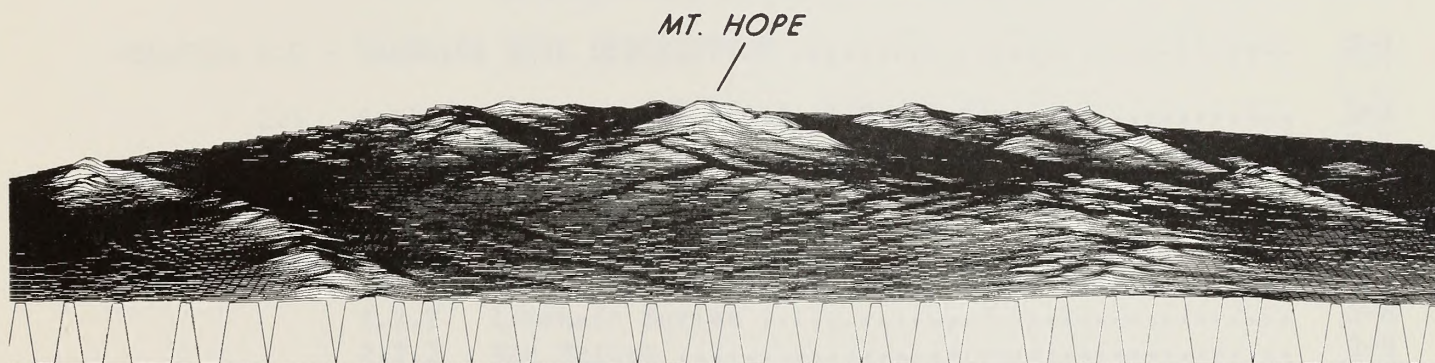
88009579

TD
195
.MS
M686
no.5

SOIL RESOURCES

TECHNICAL REPORT NO.5

MT. HOPE MOLYBDENUM PROJECT



View from the south looking north

U.S. DEPARTMENT OF INTERIOR

BUREAU OF LAND MANAGEMENT

BATTLE MOUNTAIN, NEVADA

DECEMBER 1984

BLM Library
D-553A, Building 50
Denver Federal Center
P. O. Box 25047
Denver, CO 80225-0047

TECHNICAL REPORT NO. 5

PAGE

i

TABLE OF CONTENTS (cont')

	<u>PAGE</u>
2.3.16 Labshaft-Rock Outcrop Complex - LK	2-21
2.3.17 Long - LnB	2-22
2.3.18 Mau-Shagnasty-Eightmile Association - 321	2-22
2.3.19 Ratto - RAC	2-23
2.3.20 Rock Outcrop	2-24
2.3.21 Rubyhill - RHC	2-24
2.3.22 Shagnasty-Roca-Rock Association - 764	2-25
2.3.23 Shipley (silt loam, 0 to 2 percent slopes) - ShA	2-25
2.3.24 Shipley (silt loam, moderately saline - alkali, 0-2 percent slopes) - SlA	2-26
2.3.25 Shipley (silt loam, 0-2% slopes, occasionally flooded) - SMA	2-26
2.4 Soils of Proposed and Alternative Component Areas	2-27
2.4.1 Soils of Old Lake Bottoms, Old Flood Plains, Low Lake Terraces and Recent Alluvial Fans	2-27
2.4.1.1 Nayped-Shipley Association (1)	2-29
2.4.1.2 Playas-Dianeve Association (2)	2-29
2.4.1.3 Kobeh-Alhambra Association (3)	2-30
2.4.2 Soils of Old Alluvial Fans, Terraces, Pediments and Foothills	2-31
2.4.2.1 Rubyhill Association (4)	2-31
2.4.2.2 Umil-Bobs Association (5)	2-32
2.4.2.3 Fairydele-Gabel Association (6)	2-33
2.4.2.4 Silverado-Hayeston-Credo Association (7)	2-34
2.4.2.5 Ratto-Handy-Pedoli Association (8) ...	2-35
2.4.3 Soils of the Hills and Mountains	2-36
2.4.3.1 Fera-Roca-Devoy Association (9)	2-36
2.4.3.2 Labshaft-Hopeka Association (10)	2-38
2.4.3.3 Sheege-Fusulina-Croesus Association (11)	2-38
2.4.3.4 Bartine-Overland-Atrypa Association (12)	2-39
CHAPTER 3.0 - IMPACT ANALYSIS	3-1
3.1 Introduction	3-1
3.2 Assumptions and Analysis Guidelines	3-1
3.3 Soil Erosional Losses	3-7
3.3.1 Determination of Soils Affected	3-8
3.3.2 Water Erosion Impacts	3-8
3.3.3 Wind (Aeolian) Losses	3-16
3.3.4 Corridor Right-of-way Impacts	3-21
3.4 Impacts to Soils Resource Capabilities	3-22

TABLE OF CONTENTS (con't)

	<u>PAGE</u>
CHAPTER 4.0 - LIST OF PREPARERS.....	4-1
CHAPTER 5.0 - SOIL GLOSSARY.....	5-1
CHAPTER 6.0 - BIBLIOGRAPHY.....	6-1

LIST OF TABLES

<u>TABLE NO.</u>	<u>TITLE</u>	<u>PAGE</u>
1-1	Summary Details of the Proposed Action and Alternatives Including the No Action Alternative	1-11
2-1	Classification of Soil Series, Mt. Hope Area	2-5
3-1	Soils Within the Proposed Project Area Boundary Mt. Hope, Nevada	3-9
3-2	Soil Associations Along the Proposed and Alternative Power Line Routing Corridors	3-10
3-3	Soil Associations Along the Access Road, Highway Relocation and Water Line Corridors	3-11
3-4	Soil Associations within the Proposed Alternative Tailings Pond Sites	3-12
3-5	Specific Values Used in Water Erosion Calculations	3-15
3-6	Estimated Water Erosion Losses at the Tailings Pond Dam Face (in tons/acre/year)	3-17
3-7	Specific Values Used in Wind Erosion Calculations	3-19
3-8	Estimated Wind Erosion Losses on Surface of Tailings Pond (per acre)	3-20
3-9	Criteria for Rating Topsoil Suitability for Use as Cover-soil Material in Western Stripmine Reclamation ...	3-24
3-10	Salvageable Topsoil Depths and Volumes	3-25

LIST OF FIGURES

<u>FIGURE NO.</u>	<u>TITLE</u>	<u>PAGE</u>
1-1	State Map of Nevada	1-3
1-2	Proposed Project and Land Acquisition Area Map, Alternative 1-A.....	1-4
1-3	Regional Study Area Map Showing Proposed Action Components	1-5
1-4	Proposed Action	1-6
1-5	Regional Study Area Map Showing Alternative Components 2 and 3 to the Proposed Action.....	1-7
1-6	Alternative Routing Corridors for Water Line Right-of-Way	1-8
1-7	Regional Study Area Map Showing Alternative Component 4 to the Proposed Action.....	1-9
1-8	Alternative Land Acquisition Area.....	1-10
2-1	Soils of the Mt. Hope Area	2-6
2-2	Regional Soils Map	2-28
3-1	Fence and Top Soil Storage Plans	3-5

CHAPTER 1.0
INTRODUCTION

1.1 Introduction

This technical report presents detailed information concerning the soils resource base and any significant potential impacts to that resource base upon implementation of the proposed action and/or alternatives. Additionally discussed is the soils resource capability for reclamation following project impacts.

1.2 Project Description

Technical Report No. 1 and Chapter 2.0 of the Mt. Hope Molybdenum Project EIS detail the proposed action and alternatives. In brief, the Mt. Hope Molybdenum Project Environmental Impact Statement (EIS) (including Technical Reports Nos. 1 thru 9) have been prepared in response to an EXXON Minerals Company (EXXON) proposal submitted to the Bureau of Land Management (BLM) for the purchase of public lands under Section 203 of the Federal Land Policy and Management Act (FLPMA) of 1976. Although the land purchase proposal is the action which occasions the Environmental Impact Statement (EIS) process, there are other federal decisions which must be made before EXXON may proceed. Among these are the granting of power, water line and highway relocation rights-of-way and the approval of a plan-of-operation.

The primary purpose of the proposed sale of public lands involves the planned activities of EXXON which has for some time been conducting preliminary feasibility studies assessing the development of a molybdenum deposit in the vicinity of Mt. Hope near Eureka, Nevada. As part of the EIS process, EXXON has detailed its preliminary plans concerning project development. The Mt. Hope project includes the development of an open-pit mine, non-mineralized material storage areas (2), a process plant complex of approximately 100 acres and a tailings material disposal site. As support features to the project, a proposed water line and power line would also be necessary. The proposed tailings pond site would, if implemented, require an approximate six mile relocation of an existing state highway (State Route 278).

Figures 1-1 through 1-8 show project area location and depict the proposed action and alternatives (except the location of a subdivision plat). Table 1-1 outlines the components of the proposed action and alternatives, including the no action alternative.

1.3 Baseline Data Development

Early in the EIS process, the BLM and EXXON agreed in a Memorandum of Understanding (MOU) that the EIS process of data collection, analysis and documentation would be assisted by the involvement of an independent third party consultant, Wyatt Research and Consulting, Inc. (WRC). WRC initiated its involvement as an oversight quality assurance consultant in the development of a project source document for subsequent use in developing the Mt. Hope Molybdenum Project EIS. Entitled the Mt. Hope Molybdenum Project Environmental Impact Report (EIR), the source document included two chapters of information concerning environmental resources (baseline data and impact analyses) prepared by WRC with assistance from the BLM and available study results of EXXON (e.g. cultural resources consultant report, geology, etc.). During the preparation of the source document and continuing throughout the EIS process, WRC has collected, reviewed and analyzed pertinent data in each of the necessary topical areas of environmental resources.

This technical report documents the majority of information gathered and analyzed that was pertinent to soil resources. The primary sources of soils resource information included the following:

1. Buol, S. W., F. D. Hole and R. J. McCracken. 1973. Soil Genesis and Classification. Iowa State University Press. Ames, Iowa.
2. Soil and Land Use Technology, Inc. 1980. Soils of the Antelope Valley-Roberts Mountain Area, Eureka and Lander Counties, Nevada. Vol. I. Order 3 Soil Inventory in the BLM Battle Mountain District.
3. Soil Conservation Service (SCS), Archer. 1980. Soil Survey of Diamond Valley Area - Parts of Eureka, Elko and White Pine Counties, Nevada. U.S. Dept. of Agriculture, Soil Conservation Service and U.S. Dept.

OREGON

IDAHO

Winnemucca

Battle Mountain

Elko

Carlin

SALT LAKE CITY

UTAH

Mt. Hope

RENO

Carson City

80

8A

270

Austin

Eureka

Ely

50

NEVADA

BATTLE MOUNTAIN
BLM DISTRICT

FRESNO

CALIFORNIA

LAS VEGAS

15

ARIZONA

SCALE: APPROX.

0 88.5 KM

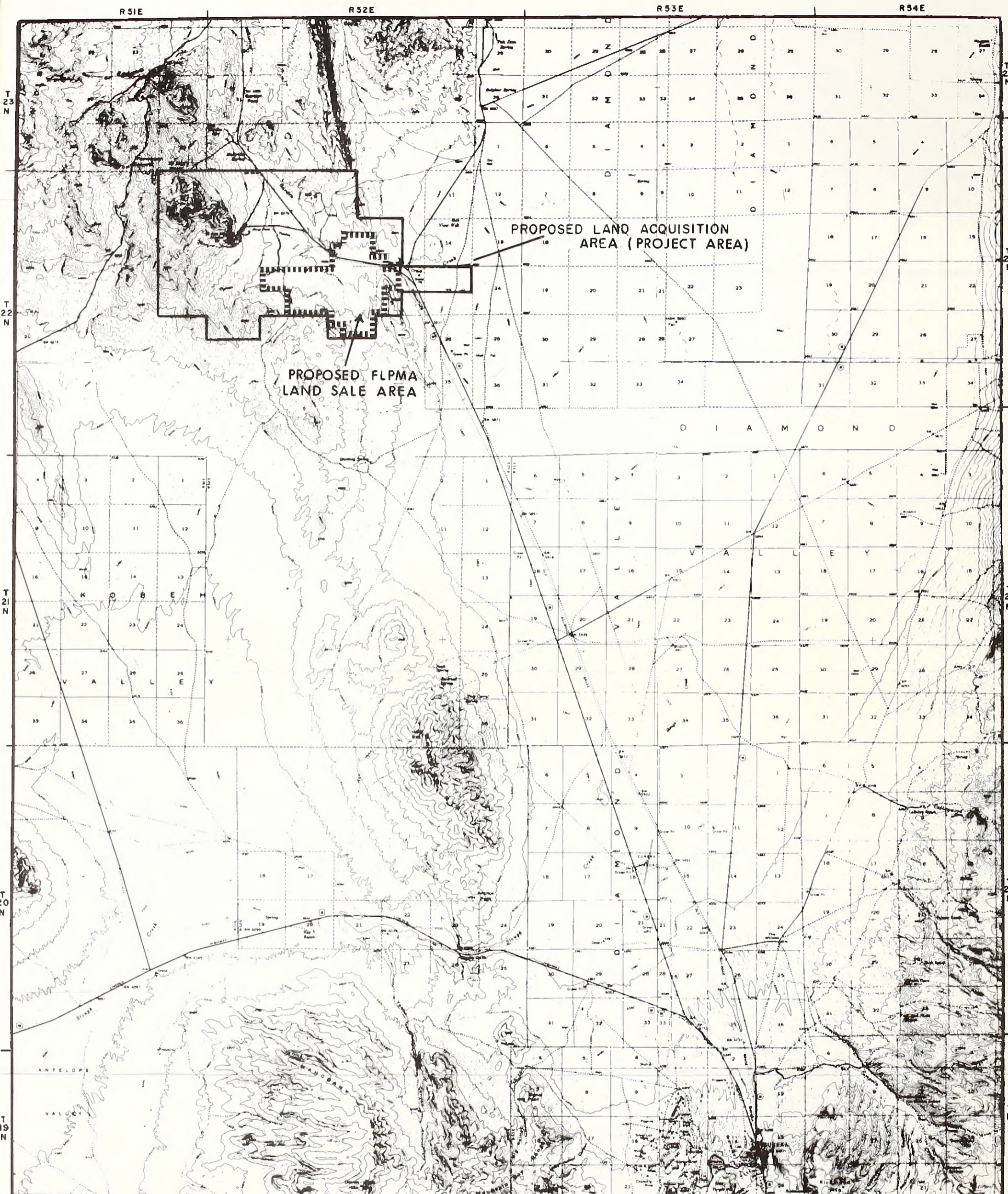
0 55 MILES

MT. HOPE
MOLYBDENUM PROJECT

STATE MAP OF
NEVADA

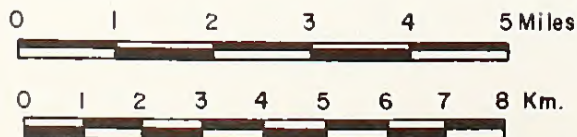
U.S. Department of the Interior
Bureau of Land Management

FIGURE
1-1



PROPOSED LAND ACQUISITION AREA (PROJECT AREA)

ESTIMATION OF APPROXIMATE FEDERAL LAND
POLICY AND MANAGEMENT ACT (FLPMA)
SALE AREA



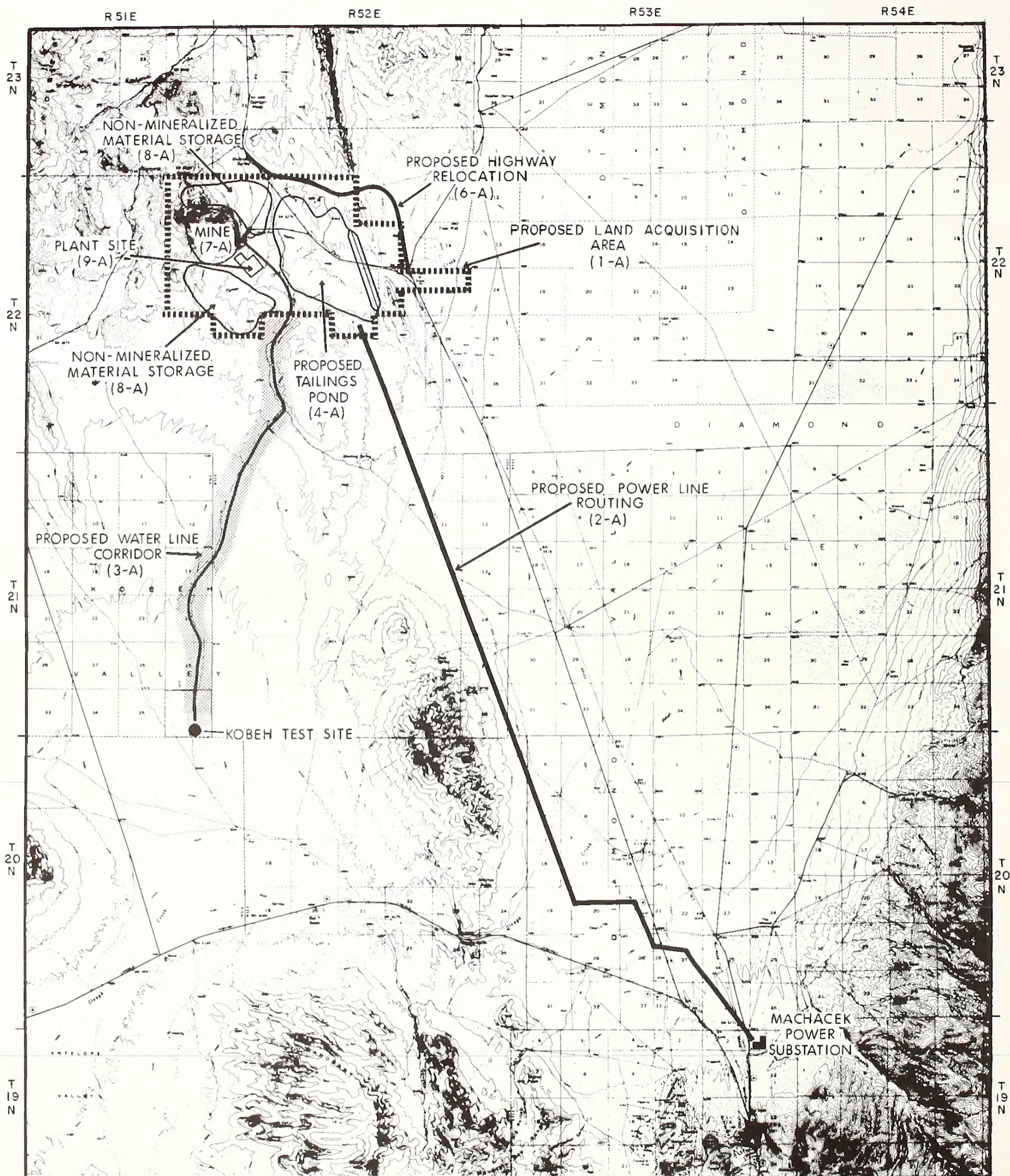
MT. HOPE MOLYBDENUM PROJECT

PROPOSED PROJECT AND LAND
ACQUISITION AREA MAP
ALTERNATIVE 1-A

U.S. Department of the Interior
Bureau of Land Management

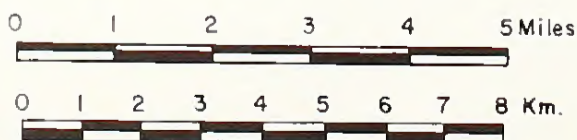
FIGURE 1-2

BASE: USGS TOPO QUADRANGLES, GARDEN VALLEY, WHISTLER MTN., DIAMOND SPRINGS
& EUREKA, NEVADA.



..... PROPOSED LAND ACQUISITION AREA BOUNDARY

*NOTE: COMPONENT 5-A (HOUSING SUBDIVISION) NOT SHOWN.
ALTERNATIVE 1-A (INCLUDING FLPCA LAND SALE AREA) SHOWN
ON FIGURE 2-1.



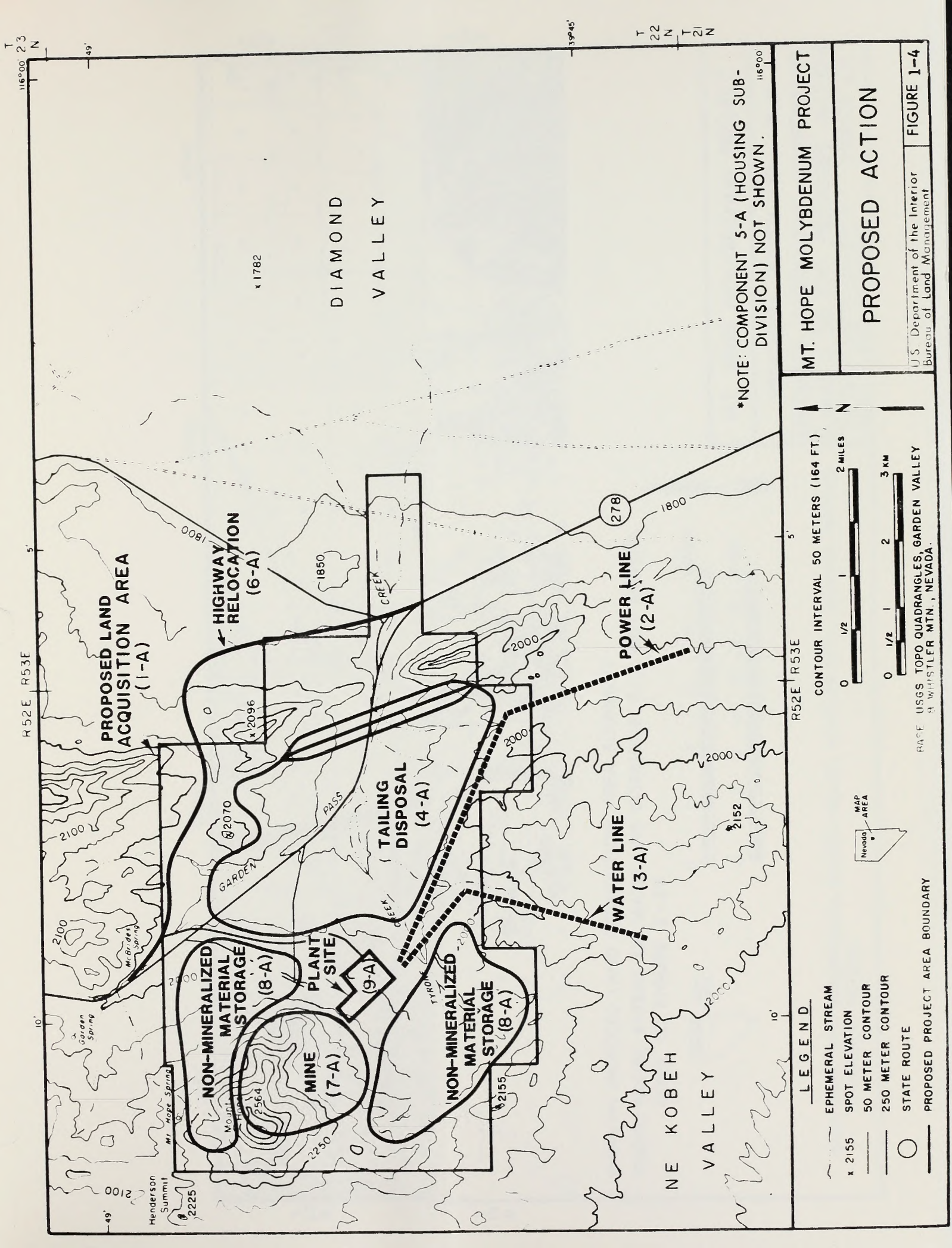
MT. HOPE MOLYBDENUM PROJECT

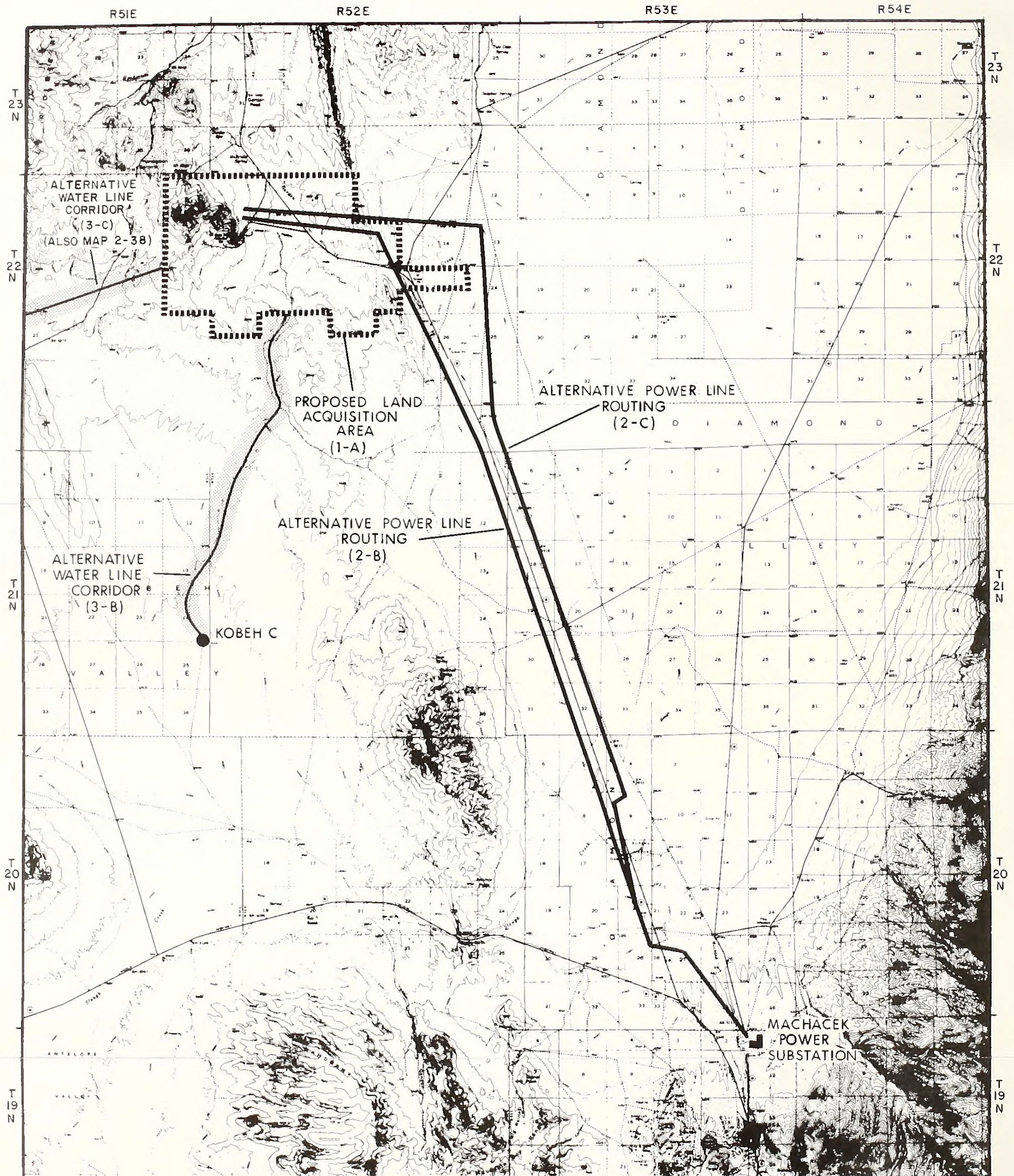
REGIONAL STUDY AREA MAP SHOWING PROPOSED ACTION COMPONENTS

U.S. Department of the Interior
Bureau of Land Management

FIGURE 1-3

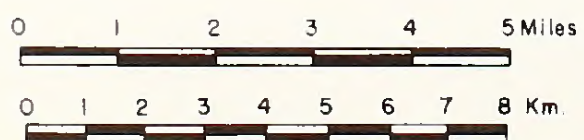
BASE: USGS TOPO QUADRANGLES, GARDEN VALLEY, WHISTLER MTN., DIAMOND SPRINGS
& EUREKA, NEVADA.





----- PROPOSED LAND ACQUISITION AREA BOUNDARY

*NOTE: ENTIRE EXTENT OF WATER LINE CORRIDOR 3-C NOT SHOWN, REFER TO FIGURE 2-3B



MT. HOPE MOLYBDENUM PROJECT	
REGIONAL STUDY AREA MAP SHOWING ALTERNATIVE COMPONENTS 2 AND 3 TO THE PROPOSED ACTION	
U.S. Department of the Interior Bureau of Land Management	FIGURE 1-5

BASE: USGS TOPO QUADRANGLES, GARDEN VALLEY, WHISTLER MTN., DIAMOND SPRINGS & EUREKA, NEVADA.

R50E

R51E

R52E

T 23 N

T 22 N

T 21 N

T 20 N

KOBEB A

ALTERNATIVE 3
WATER LINE CORRIDOR 3-C
(Component Alternative)ALTERNATIVE 3
WATER LINE CORRIDOR 3-B
(Proposed Action)

KOBEB C

KOBEB TEST SITE
Proposed Action
3-A

PROPOSED LAND ACQUISITION AREA BOUNDARY

ALTERNATIVE WATER LINE RIGHT-OF-WAY



0 1 2 3 4 5 Miles

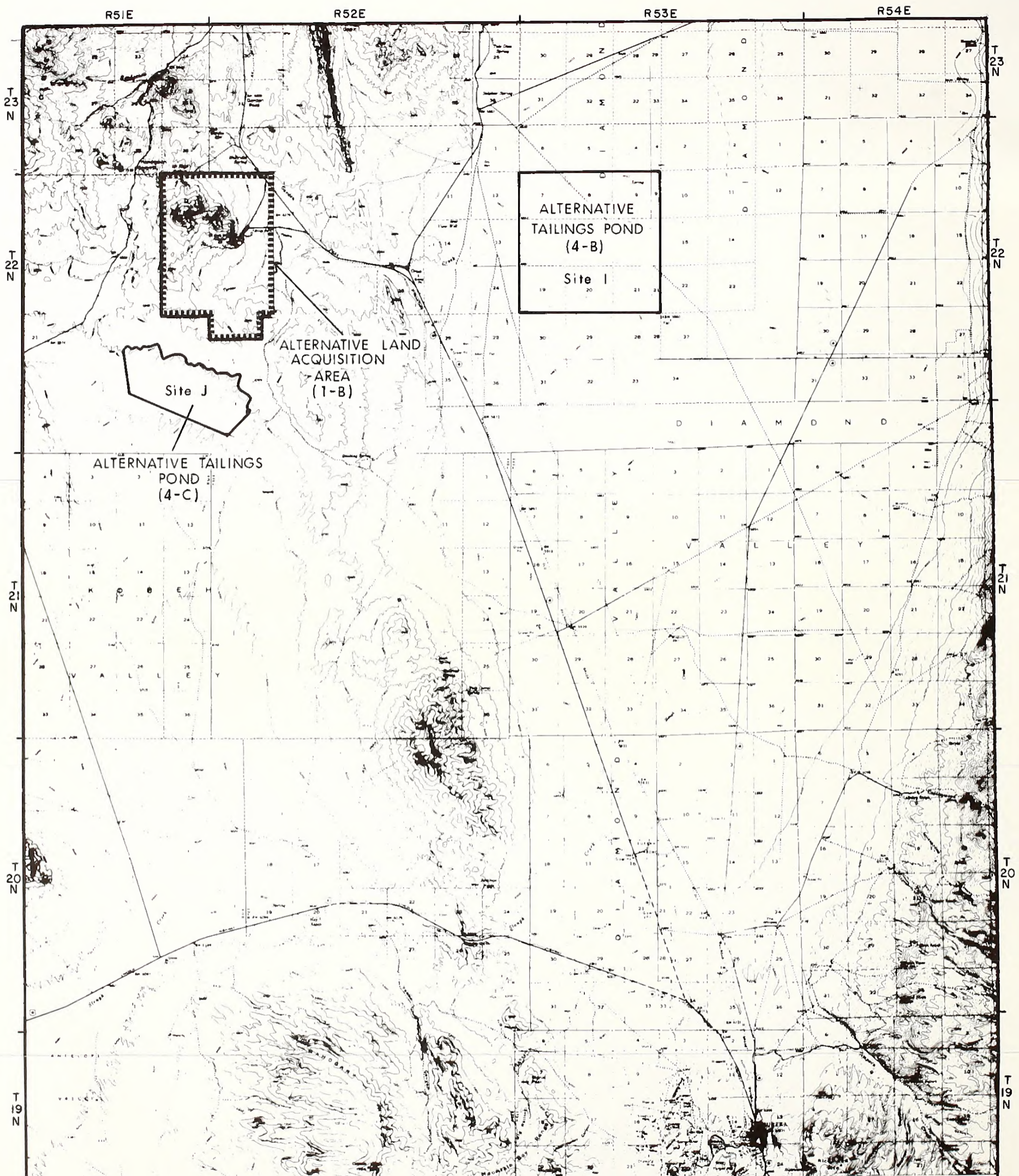
0 1 2 3 4 5 6 7 8 Km

BASE USGS TOPO QUADRANGLES, GARDEN VALLEY, WHISTLER MTN.,
ROBERTS CREEK MTN. & BARTINE RANCH, NEVADA.

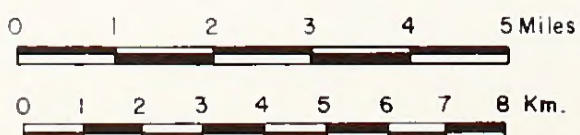
MT. HOPE MOLYBDENUM PROJECT

ALTERNATIVE ROUTING CORRIDORS
FOR WATER LINE RIGHT-OF-WAY
(ALTERNATIVE 3 CONTINUED FROM FIGURE 2-3A)U.S. Department of the Interior
Bureau of Land Management

FIGURE 1-6



----- ALTERNATIVE LAND ACQUISITION AREA BOUNDARY



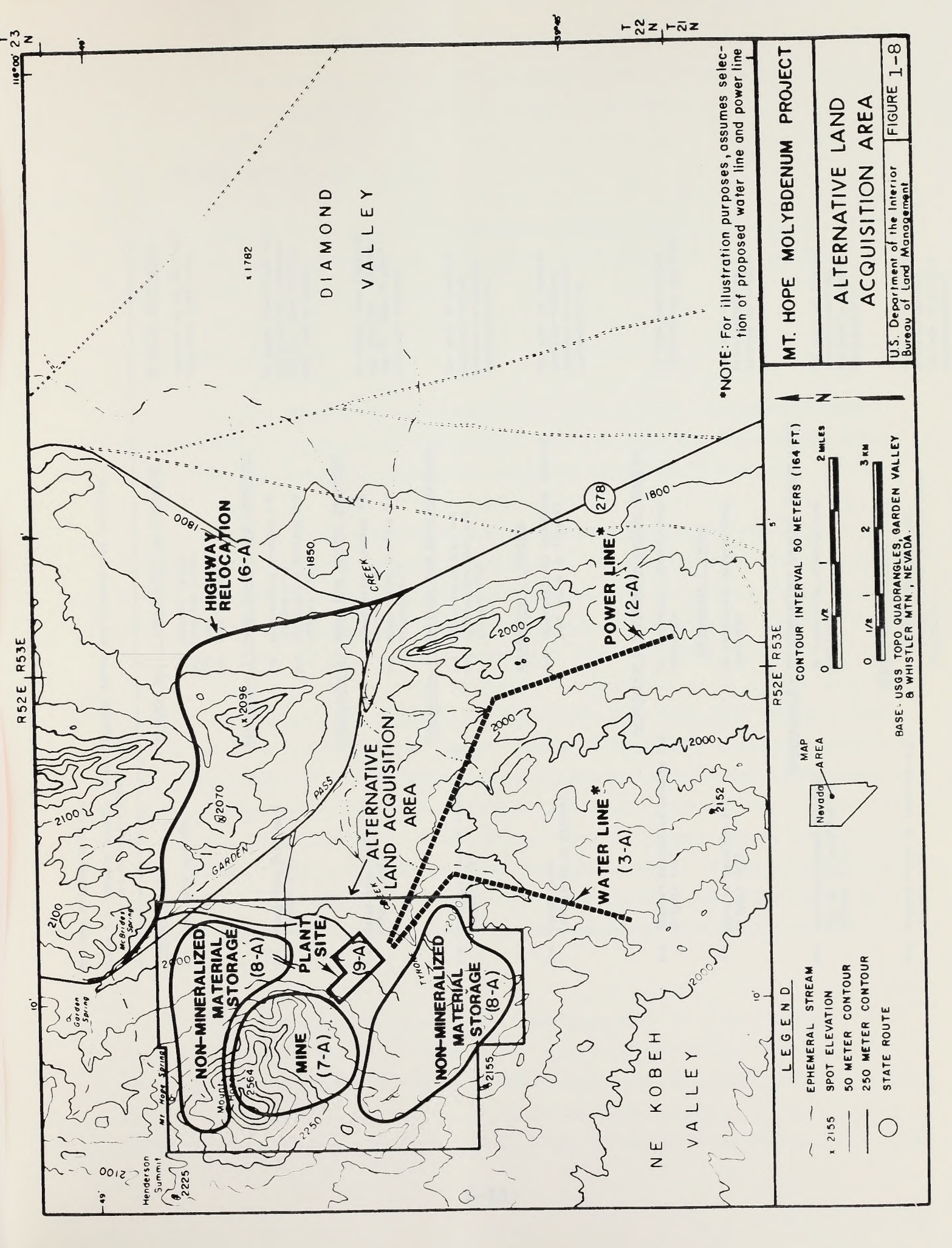
BASE: USGS TOPO QUADRANGLES, GARDEN VALLEY, WHISTLER MTN., DIAMOND SPRINGS & EUREKA, NEVADA.

MT. HOPE MOLYBDENUM PROJECT

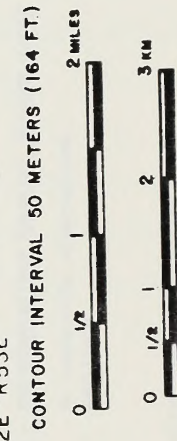
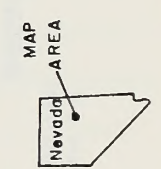
REGIONAL STUDY AREA MAP
SHOWING ALTERNATIVE COMPONENT
4 TO THE PROPOSED ACTION

U.S. Department of the Interior
Bureau of Land Management

FIGURE 1-7



- LEGEND**
- ~ EPHEMERAL STREAM
 - x 2155 SPOT ELEVATION
 - 50 METER CONTOUR
 - 250 METER CONTOUR
 - STATE ROUTE



MT. HOPE MOLYBDENUM PROJECT

ALTERNATIVE LAND ACQUISITION AREA

U.S. Department of the Interior
Bureau of Land Management

FIGURE 1-8

BASE: USGS TOPO QUADRANGLES, GARDEN VALLEY & WHISTLER MTN., NEVADA.

Mt. Hope Molybdenum Project

Table 1-1 Summary Details of the Proposed Action and Alternatives Including the No Action Alternative

<u>Proposed Action</u>	<u>Alternative 1 - Land Acquisition Components</u>	<u>No Action Alternative</u>
1-A Land Sale by FLPMA	1-B Mineral Claims 1-C Land Use Lease 1-D Land Use Permit 1-E Land Exchange	Negative or no decision regarding land sale.
<u>Alternative 2 - Power Line Routing Components</u>		
2-A Power Line Routing A (Figure 1-2)	2-B Alternative Routing 2-B (Figure 1-4)	No power line right-of-way granted. Assumes the Mt. Hope Project will not proceed.
	2-C Alternative Routing 2-C (Figure 1-4)	
<u>Alternative 3 - Water Line Routing Components</u>		
3-A Water Line Routing A (Figure 1-2)	3-B Alternative Routing 3-B (Figure 1-4)	No water line right-of-way granted. Assumes the Mt. Hope Project will not proceed.
	3-C Alternative Routing 3-C (Figure 1-5)	
<u>Alternative 4 - Tailings Pond Sites Components</u>		
4-A Tailings Pond at Location 4-A (Figure 1-3)	4-B Alternative Site 4-B 4-C Alternative Site 4-C (Figure 1-4)	Not part of federal decision-making. Assumes no project implementation.
5-A Subdivision (Not shown on figure)	<u>Alternative 5 - Housing</u> 5-B Decentralized Workforce Housing (Not shown on figure)	Not part of federal decision-making. Assumes no project implementation.
<u>Alternative 6 - Highway Relocation Component</u>		
6-A Highway Relocation Routing 6-A (Figure 1-3)	No reasonable alternatives available <u>Alternative 7 - Mine</u>	No road relocation right-of-way granted.
7-A Mine at Location 7-A (Figure 1-3)	No reasonable alternatives available	Not part of federal decision-making. Assumes no project implementation.
<u>Alternative 8 - Non-Mineralized Material Storage Areas</u>		
8-A Non-Mineralized Material Storage at Location 8-A (Figure 1-3)	No reasonable alternatives available	Not part of federal decision-making. Assumes no project implementation.
9-A Process Plant at Location 9-A (Figure 1-3)	<u>Alternative 9 - Process Plant</u> No alternatives proposed. (Proposed action is worst-case. See text).	Not part of federal decision-making. Assumes no project implementation.

of the Interior, Bureau of Land Management in cooperation with University of Nevada Agricultural Experiment Station.

1.4 Impact Analyses Methodology

In the event of any discrepancies between this technical report and the EIS, the material presented in the EIS shall supercede that which is presented in this technical report.

1.4.1 Soils Mapping

Soils mapping was previously performed by the Soil Conservation Service (SCS) in November of 1980 and by Soil and Land Use Technology, Inc. (July, 1980) during their respective soil survey/inventory studies.

During these studies, the soil scientists examined soil profiles, classified and named the soils, and then drew the boundaries of the individual soils on aerial photographs (orthophotoquads) and maps. These boundaries were then transferred onto base map mylars of the project area and regional area to generate the soils maps appearing in this technical report.

A mapping unit consists of all areas shown on a soil map that are identified by a common symbol. A soil association is made up of adjacent soils which occur in a distinctive proportional pattern. These soils occur as areas large enough to be shown individually but that are shown as one unit because the time and effort of delineating them separately cannot be justified (SCS, 1980). Thus, a soil association commonly consists of one or more major soils and at least one minor soil. It is named after the major soils (e.g. Labshaft-Locane association). The soils in one association may occur in another, but in a different pattern.

Soils which have very similar profiles make up a soil series. The series, as defined by the SCS (1980), is a group of soils that formed from a particular kind of parent material and have horizons that, except for texture of the surface layer, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, texture,

structure, reaction, consistence, and mineralogical and chemical composition. Soil series are named for a geographic location near the place where the series was first observed and mapped.

Within the Soils Technical Report text, following the name of each mapping unit is a symbol that identifies the mapping unit on the detailed soils map entitled Soils of the Mt. Hope Area. The symbols consist of letters or numbers.

The reason for variance is due to the two separate soil surveys/inventories conducted within the region. The area west of Mt. Hope was surveyed by Soil and Land Use Technology, Inc. and the area east of Mt. Hope (including Diamond Valley) was surveyed by the SCS. This also led to some discrepancies in classification of similar or the same soils along the entire boundary between the surveys due to varying analysis procedures and interpretations. Soil data obtained from the two soil surveys underwent further review and comparison by Intermountain Soils (contracted by WRC). Several telephone communications between WRC/Intermountain Soils and Ed Peterson (District Soil Conservationist in Eureka) and Ed Nathan (SCS soil scientist) allowed for additional information input to establish soil identification boundaries.

The Regional Soils Map appearing in the text was primarily based upon a previous regional soils map done by the SCS (1980) with some inferred soil boundaries in Koebe Valley as a result of the previously mentioned discrepancies. It should be noted that the Regional Soils Map of this technical report is of a very broad, generalized nature and not of the same detail as the Mt. Hope soils map. This is due to the great areal extent covered by the regional map. The map only shows soil associations which have been grouped into three general kinds of landscape for broad interpretive purposes, thus providing a general idea of the soils in the area. Each area outlined on the map consists of more than one kind of soil.

1.4.2 Soils Descriptions

Soil descriptions were derived directly from the baseline data sources cited in Section 1.3. Supplemental detail was obtained through WRC communication with SCS soils scientists.

1.4.3 Determination of Soils Impacted

Soils within the land acquisition boundary area were characterized as to potential for direct impact by the use of mylar map overlay and planimetry. Overlay mylars depicting the areal extent of project components were overlain the SCS and WRC soils mapping. Boundaries were transferred onto the soils maps from which soil type acreages affected were directly planimetered. Quantity of soils affected, by type, were calculated assuming typical soil profile descriptions of horizon depth were appropriate.

It should be noted that the determination of soils impact was utilized significantly in evaluating the potential for reclamation potential. A detailed review of reclamation potential is presented in Technical Report No.6, Biota.

1.4.4 Calculation of Soil Losses

Section 3.0 of this technical report details the individual calculations conducted for aeolian (wind) and water erosion losses.

CHAPTER 2.0
BASELINE SOIL DESCRIPTION

2.1 Soil Development and Physical Properties

2.1.1 Soil Development

The soil development in the area of investigation has been greatly influenced by climatic, geologic and topographic factors. The physiographic features of the Basin and Range Province often delineate soil type boundaries.

Low precipitation results in sparse vegetation cover and little organic matter (humus), thus light colored soils are formed. Leaching of the soluble weathering products only takes place to about 12 to 36 inches (30 to 91 cm.) below the surface due to the limited precipitation (Buol et al, 1973). The accumulation of calcium carbonates beneath the surface is common. These accumulations often form layered zones (horizons) and take the form of hardened caliche layers. Silica, derived from volcanic tuffs, may accumulate in subsurface horizons and cement into a hardpan known as duripan.

When rainfall does occur, it typically comes from thunderstorms and is of high intensity but short duration. Water runoff from the higher elevations causes sheet, rill and gully erosion of the soils on the alluvial fans. The runoff eventually reaches the valley bottoms and playas where it ponds. Because these soils are periodically flooded, and the water subsequently evaporated, high concentrations of sodium and/or salt are present. The steep soils of the hills and mountains rapidly lose water by runoff. These soils are generally stony, gravelly, medium textured and well drained. Adjacent soils on the lower, more gentle slopes and valleys receive and absorb more of the runoff. These soils are moderately coarse to fine textured with some gravel and are slow to well drained. A description of the soils characteristic to the physiographic features in the area are as follows:

- 1) The playas and their associated soils consist of deposits that are light-colored, deep and clayey with very high accumulations of salt and alkali. Any free water from melting snow and summer thunderstorms usually ponds on

their level surfaces. In general, their permeability and surface runoff are very slow and the erosion hazard is slight as long as the surface is undisturbed. When dry, repeated passes of vehicular traffic along the same path will powder the surface layer, creating a severe wind erosion hazard. When wet, such areas are generally sticky, have little bearing capacity and are virtually impassable to all wheeled vehicles and most animals. Salt crusting sometimes occurs during dry periods.

- 2) The valley bottoms and flood plains have smooth to gently undulating slopes (0 to 4 percent) with deep and moderate to very strongly alkaline and saline soils. The surface textures range from loams to silty clay loams, while the subsoils range from fine-loamy to fine silty. Permeability ranges from very slow to moderately rapid and the hazard of wind erosion of the disturbed soil is moderate throughout the bottom land areas.
- 3) The alluvial fans and stream and lake terraces make up the largest areas in the valleys. Slopes range from smooth to rolling (0 to 15 percent) and the soils are shallow to deep and mildly to strongly alkaline. The surface textures range from fine sands to gravelly sandy loams and silty clay loams, while the subsoils range from sands to loamy skeletal to fine loamy. In general, the gravel content of the deposits increases near mountain fronts. The permeability of these soils ranges from slow to rapid. Accumulations of calcium carbonate and silica at 12 to 36 inches (30 to 91 cm.) below the surface often take the form of caliche layers and duripans - indurated, virtually impermeable layers that limit effective root penetration. During high intensity rainstorms, the soils of the alluvial fans will undergo sheet erosion and rill and gully formation.
- 4) The uplands and mountains have slopes ranging from steep to very steep (over 30 percent) and have shallow to deep, moderately alkaline to medium acid soils. Surface textures range from cobbly to sandy to gravelly loams, while the subsoils range from loamy skeletal to clayey skeletal. These soils are often underlain by bedrock within 20 inches (51 cm.).

Many soils of the lower elevations are covered by a surface pavement of small and large rock fragments. This "desert pavement" condition is caused

by the winnowing action of winds, thereby removing the finer soil particles and leaving a rock fragment surface which protects the soils from further water and wind erosion. Construction and off-road vehicular activities can remove or disturb the desert pavement, significantly increasing soil erodibility.

2.1.2 Agronomic Properties

A discussion of the agronomic potential of the soils of the study region can be facilitated by examining and discussing the soils on the basis of their classification in Soil Taxonomy. The broadest class in Soil Taxonomy is the order; because of the definitions used to establish the classes in Soil Taxonomy, the soil order is a convenient vehicle through which agronomic properties can be discussed.

The dominant soil order of the soils within the study region is Aridisols. As the name implies, they are usually dry and are never moist more than three consecutive months during the growing season. Aridisols are low in organic matter and thus light colored, and many have accumulations of calcium carbonate, silica and/or gypsum in their subsurface horizons. These soils are found in the study area primarily on the alluvial fans, lake terraces and the valley bottoms. The Aridisols of the study area can only be cultivated if properly irrigated and drained.

On the higher mountain sideslopes surrounding the valleys, soils of the Mollisol order may be found associated with Aridisols. Although they are almost as dry as the Aridisol, they characteristically have a dark surface layer due to accumulation of organic matter. Mollisols are some of the world's most productive soils. The Mollisols found in the study area, however, are generally located on mountain sideslopes and are not suited for cultivation due to steep slopes and rapid water runoff.

Entisols, an order of recently-formed or actively eroding soils, lack developed subsurface horizons. They are found associated with Aridisols on the landscape. The Entisols found within the study area will only be productive if adequately fertilized and irrigated. Frequently, however, restrictions due to their depth or water holding capacity preclude their cultivation.

Inceptisols are termed young soils because their subsoils contain horizons that have been recently formed or slightly altered from the underlying parent material. These soils are found in the study area on floodplains, low terraces and on margins of playas. They are suitable for cultivation if adequately irrigated, fertilized and drained.

2.2 Principle Soil Series

Most soils of the Mt. Hope area are common to Diamond Valley and the surrounding areas. The soils in the Mt. Hope area are classified and listed in Table 2-1. Figure 2-1 depicts soils in the Mt. Hope area. There are four principle soil series present within the project area. These series are Ratto (map unit RAC); Labshaft (map units LK, LAF and LAE); Mau (map unit 321); and, Atrypa (map unit AT and 831). The following discussion describes these five principle soil series as compiled by the SCS for Diamond Valley (1980). The soils specifically found within the proposed project area boundary are listed in Table 3-1, (Section 3.1) with their respective acreages.

2.2.1 Atrypa Series

The Atrypa series consists of well-drained soils that formed in residuum from soft shale and has minor amounts of limestone, dolomite and conglomerate rocks. These soils are on hills and mountains. Slope ranges from 4 to 75 percent. The vegetation is big sagebrush, squirreltail, Sandberg bluegrass, pinyon and juniper. Elevation is 6,400 to 7,000 feet. Average annual precipitation is 12 to 14 inches, average annual air temperature is 42° to 46° F, and the frost-free season is 50 to 100 days.

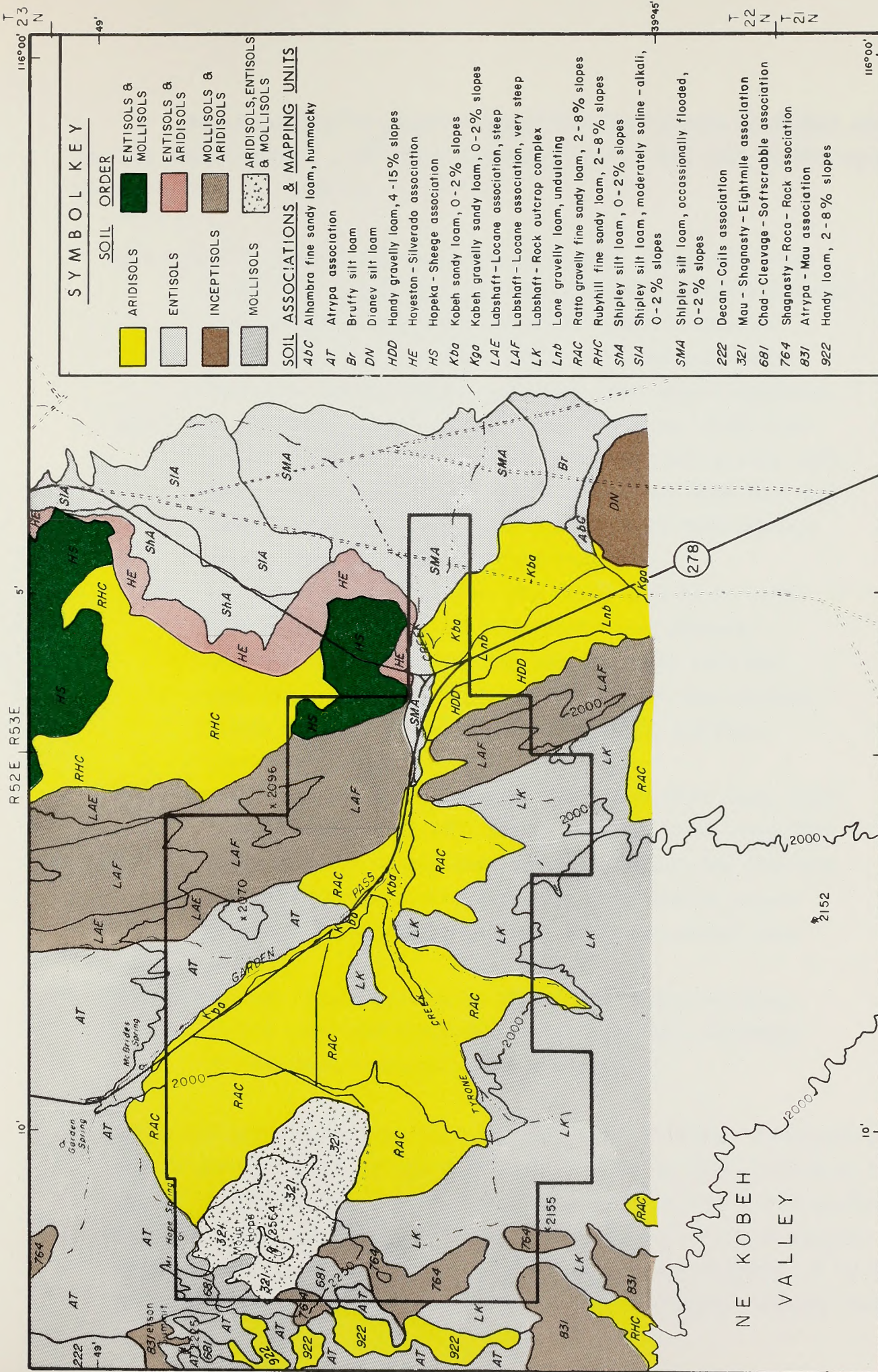
In a representative profile the surface layer is grayish brown loam about 7 inches thick. Below this is brown and light brownish gray loam about 6 inches thick. Shale bedrock is at a depth of 13 inches. Permeability is moderate. Effective rooting depth is 10 to 20 inches. Available water capacity is low.

Mt. Hope Molybdenum Project

Table 2-1 Classification of Soil Series, Mt. Hope Area

Soil Series	Family	Subgroup	Order
<u>Alhambra</u>	Coarse-loamy, mixed (calcareous), frigid	Durorthidic Xeric Torrifluvents	Entisols
<u>Atrypa</u>	Loamy, mixed, frigid, shallow	Calciorthidic Haploxerolls	Mollisols
<u>Bruffy</u>	Fine-loamy, mixed (calcareous), frigid	Xeric Torrifluvents	Entisols
<u>Chad</u>	Fine, montmorillonitic, frigid	Aridic Argixerolls	Mollisols
<u>Coils</u>	Fine, montmorillonitic, frigid	Haploxerollic Durargids	Aridisols
<u>Cleavage</u>	Loamy-skeletal, mixed, frigid	Lithic Argixerolls	Mollisols
<u>Decan</u>	Fine, montmorillonitic, frigid	Aridic Durixerolls	Mollisols
<u>Devoy *</u>	Clayey-skeletal, montmorillonitic	Argic Cryoborolls	Mollisols
<u>Diane</u>	Fine-loamy, mixed (calcareous), frigid	Aeric Haplaquepts	Inceptisols
<u>Eightmile</u>	Loamy-skeletal, mixed, nonacid, frigid, shallow	Xeric Torriothents	Entisols
<u>Handy</u>	Fine, montmorillonitic, frigid	Xerollic Haplargids	Aridisols
<u>Hayeston</u>	Coarse-loamy, mixed (calcareous), frigid	Xeric Torriothents	Entisols
<u>Holtle *</u>	Coarse-loamy, mixed, frigid	Aridic Duric Haploxerolls	Mollisols
<u>Hopeka</u>	Loamy-skeletal, carbonatic, frigid	Lithic Xeric Torriothents	Entisols
<u>Kobeh</u>	Loamy-skeletal, mixed, frigid	Durixerollic Camborthids	Aridisols
<u>Labshaft</u>	Loamy-skeletal, mixed	Lithic Cryoborolls	Mollisols
<u>Locane</u>	Clayey-skeletal, montmorillonitic, frigid	Lithic Xerollic Haplargids	Aridisols
<u>Lone</u>	Loamy-skeletal, mixed, frigid	Xerollic Durorthids	Aridisols
<u>Mau</u>	Clayey-skeletal, montmorillonitic, frigid	Durixerollic Haplargids	Aridisols
<u>Nayped *</u>	Fine-loamy, mixed, frigid	Durixerollic Camborthids	Aridisols
<u>Pedoli *</u>	Fine-loamy, mixed, frigid	Xerollic Haplargids	Aridisols
<u>Ratto</u>	Clayey, montmorillonitic, frigid, shallow	Xerollic Durargids	Aridisols
<u>Roca</u>	Clayey-skeletal, montmorillonitic, frigid	Xerollic Haplargids	Aridisols
<u>Rubyhill</u>	Fine-loamy, mixed, frigid	Xerollic Haplargids	Aridisols
<u>Shagnasty</u>	Fine, montmorillonitic, frigid	Haploxerollic Durorthids	Aridisols
<u>Sheege</u>	Loamy-skeletal, carbonatic	Aridic Calcic Argixerolls	Mollisols
<u>Shipley</u>	Coarse-loamy, mixed (calcareous), frigid	Cryic Lithic Rendolls	Mollisols
<u>Silverado</u>	Coarse-loamy, mixed, frigid	Xeric Torriothents	Entisols
<u>Softscrabble</u>	Loamy-skeletal, mixed, frigid	Durixerollic Camborthids	Aridisols
<u>Umil *</u>	Fine-loamy, mixed, frigid	Pachic Argixerolls	Mollisols
<u>Walti *</u>	Fine, montmorillonitic, frigid	Xerollic Durorthids	Aridisols
<u>Welch *</u>	Fine-loamy, mixed, frigid	Aridic Argixerolls	Mollisols
		Cumulic Haplaquolls	Mollisols

* These are lesser soils which are included in the mapping of various associations and make up small percentages of the acreage within the Mt. Hope area.



SYMBOL KEY

SOIL ORDER

ARIDISOLS	ENTISOLS & MOLLISOLS
ENTISOLS	ENTISOLS & ARIDISOLS
INCEPTISOLS	MOLLISOLS & ARIDISOLS
MOLLISOLS	ARIDISOLS, ENTISOLS & MOLLISOLS

SOIL ASSOCIATIONS & MAPPING UNITS

Abc	Alhambra fine sandy loam, hummocky
AT	Atrypa association
Br	Bruffy silt loam
DN	Diane silt loam
HDD	Handy gravelly loam, 4-15% slopes
HE	Hayeston - Silverado association
HS	Hopeka - Sheege association
Kba	Kobeh sandy loam, 0-2% slopes
Kga	Kabeh gravelly sandy loam, 0-2% slopes
LAE	Labshaft - Locane association, steep
LAF	Labshaft - Locane association, very steep
LK	Labshaft - Rock outcrop complex
Lnb	Lone gravelly loam, undulating
RAC	Ratto gravelly fine sandy loam, 2-8% slopes
RHC	Rubhill fine sandy loam, 2-8% slopes
SIA	Shipley silt loam, 0-2% slopes
SMA	Shipley silt loam, moderately saline - alkali, 0-2% slopes
SMA	Shipley silt loam, occasionally flooded, 0-2% slopes
222	Decan - Coils association
321	Mau - Shagnasty - Eightmile association
681	Chad - Cleavage - Softscrabble association
764	Shagnasty - Roca - Rock association
831	Atrypa - Mau association
922	Handy loam, 2-8% slopes

LEGEND

- EPHEMERAL STREAM
- SPOT ELEVATION
- SOIL MAPPING UNIT BOUNDARY
- 250 METER CONTOUR
- STATE ROUTE
- PROPOSED PROJECT AREA BOUNDARY

CONTOUR INTERVAL 50 METERS (164 FT)



BASE: MODIFIED USGS TOPO QUADRANGLES, GARDEN VALLEY & WHISTLER MTN., NEVADA.

MT. HOPE MOLYBDENUM PROJECT

SOILS OF THE MT. HOPE AREA

U.S. Department of the Interior
Bureau of Land Management

FIGURE 2-1

Representative profile of Atrypa loam in an area of Atrypa association in Eureka County, 2,350 feet north, and 2,400 feet west of the southeast corner of sec. 31, T. 23 N., R. 52 E.:

- A11 - 0 to 2 inches; grayish brown (10YR 5/2) loam, dark brown (10YR 3/3) moist; moderate fine granular structure; soft, very friable, slightly sticky and slightly plastic; common fine and very fine roots; few fine and common very fine tubular pores; neutral; clear smooth boundary.
- A12 - 2 to 7 inches; grayish brown (10YR 5/2) loam, dark brown (10YR 3/3) moist; moderate fine granular structure; soft, very friable, sticky and slightly plastic; many fine and very fine roots; few fine and common very fine tubular pores; neutral; gradual smooth boundary.
- Clca- 7 to 10 inches; brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; many fine and very fine roots; few fine and common very fine tubular pores; slightly effervescent; moderately alkaline; clear wavy boundary.
- C2ca- 10 to 13 inches, light brownish gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; massive; hard, very friable, slightly sticky and slightly plastic; few fine and common very fine roots; many very fine tubular pores; strongly effervescent; strongly alkaline; abrupt wavy boundary.
- Cr - 13 inches, shale bedrock of the Vinini Formation; lime-coated seams and fractures; this shale has a hardness of less than 3 and is highly fractured.

The A1 horizon ranges from the fine sandy loam to loam. Structure is weak to strong, fine and medium granular, or it is weak, medium or thick, platy. In some places as much as 15 percent gravel is on the surface. Reaction ranges from pH 6.6 to 7.8. The thickness of the A horizon ranges from 7 to 10 inches. The Cca horizon ranges from pH 7.9 to 9.0. It is massive or has weak, subangular blocky structure. The Cca horizon

has less than 15 percent carbonates. Shale bedrock is at a depth of 10 to 20 inches.

2.2.2 Labshaft Series

The Labshaft series consists of well-drained soils that formed in residuum from siliceous rocks, including chert, greenstone and conglomerate. These soils are on hills and north-facing mountainsides. Slope ranges from 15 to 75 percent. The vegetation is pinyon, juniper, big sagebrush, Nevada ephedra, Sandberg bluegrass and bluebunch wheatgrass. Elevation is 6,500 to 8,000 feet. Average annual precipitation is 10 to 14 inches, average annual air temperature is 42° to 45°F, and the frost-free season is 50 to 70 days.

In a representative profile the surface layer is grayish brown stony loam and gravelly loam about 12 inches thick. The next layer is yellowish brown gravelly sandy clay loam about 7 inches thick. Below this is siliceous conglomerate bedrock. Permeability is moderate or moderately slow. Effective rooting depth is 10 to 20 inches. Available water capacity is very low.

Representative profile of Labshaft very stony loam in Eureka County, 3,300 feet south and 4,350 feet east of the northwest corner of sec. 5, T. 23 N., R. 52E:

A11 - 0 to 4 inches; grayish brown (10YR 5/2) very stony loam, very dark grayish brown (10YR 3/2) moist; moderate very fine granular structure; soft, friable, slightly sticky and slightly plastic; many coarse and medium and common fine and very fine roots; many very fine and fine interstitial pores; class 3 stoniness; 30 percent gravel and 20 percent cobbles; neutral; clear smooth boundary.

A12 - 4 to 12 inches; grayish brown (10YR 5/2) gravelly loam, dark brown (10YR 3/3) moist; massive; slightly hard, friable, sticky and slightly plastic; many coarse,

medium, and very fine and common fine roots; few fine and many very fine tubular pores; 40 percent gravel and cobbles; neutral; clear wavy boundary.

B2 - 12 to 19 inches; yellowish brown (10YR 5/4) gravelly sandy clay loam, dark yellowish brown (10YR 4/4) moist; massive; slightly hard, friable, sticky and plastic; few coarse, many medium, and common fine and very fine roots; few fine and many very fine tubular pores; 3 percent stones, 40 percent gravel and cobbles; neutral; abrupt irregular boundary.

R - 19 inches; siliceous conglomerate bedrock.

The A horizon is gravelly to extremely stony very fine sandy loam or heavy loam. Thickness ranges from 6 to 14 inches. The B2 horizon is gravelly to very stony loam, clay loam or sandy clay loam. It has blocky structure, or it is massive. Content of coarse fragments ranges from 40 to 70 percent. Depth to bedrock is 10 to 20 inches.

2.2.3 Mau Series

The Mau series consists of well-drained soils that formed in residuum and colluvium from andesite and basalt. These soils are on old volcanic cones and flows. Slope ranges from 15 to 30 percent. The vegetation is big sagebrush, low sagebrush, Sandberg bluegrass, and squirreltail. Elevation is 6,000 to 7,000 feet. Average annual precipitation is 8 to 12 inches, average annual air temperature is 42° to 45°F, and the frost-free season is 70 to 100 days.

In a representative profile the surface layer is light gray and light brownish gray stony heavy loam about 6 inches thick. The next layer is light brownish gray gravelly clay loam about 7 inches thick. Below this is dark brown very gravelly clay and very gravelly light clay about 15 inches thick. This is underlain by white very gravelly clay loam about 6 inches thick. Andesite bedrock is at a depth of 34 inches. Permeability is slow or moderately slow. Effective rooting depth is 20 to 40 inches. Available water capacity is low.

Representative profile of Mau stony loam, 15 to 20 percent slopes, in Eureka County, 1,800 feet north and 3,050 feet east of the southwest corner of sec. 2, T. 26N., R.53 E.:

- A1 - 0 to 6 inches; light gray and light brownish gray (10RY 6/1 and 6/20 stony heavy loam, very dark grayish brown (10YR 3/2) moist; moderate fine and very fine granular structure; soft, friable, slightly sticky and slightly plastic; many very fine interstitial pores; class 1 stoniness; 30 percent gravel; clear smooth boundary.
- Blt - 6 to 13 inches; light brownish gray (10YR 6/2) gravelly clay loam, dark grayish brown (10YR 4/2) moist; moderate very fine granular structure; slightly hard, friable, sticky and plastic; common medium and few fine and very fine roots; common very fine interstitial pores; 30 percent gravel; common thin clay films lining pores and on peds; neutral; clear wavy boundary.
- B2lt-13 to 18 inches; dark brown (10YR 4/3) very gravelly clay, dark brown (10YR 4/3) moist; strong fine and very fine angular blocky structure; very hard, firm, very sticky and very plastic; few fine and very fine roots; common very fine interstitial pores and few very fine tubular pores; 60 percent gravel; common thin clay films on peds and in pores; neutral; clear wavy boundary.
- Clsica-28 to 34 inches; white (10YR 8/2) very gravelly clay loam, light gray (10YR 7/2) moist; massive very hard, firm, sticky and very plastic; few and very fine roots; 75 percent gravel; lime-silica coats on pebbles; strongly effervescent; strongly alkaline; abrupt wavy boundary.

R - 34 inches, andesite bedrock coated with silica-lime places.

The A horizon is stony or cobbly loam or clay loam. Stoniness includes class 1 and 2. The B2t horizon is gravelly or very gravelly clay or heavy clay loam. Content of coarse fragments is 45 to 60 percent. The C horizon is slightly to moderately lime and silica enriched. It is slightly to violently effervescent and moderately alkaline or strongly alkaline. The bedrock has discontinuous lime and silica coatings on the surface and in the fractures.

2.2.4 Ratto Series

The Ratto series consists of well-drained soils that formed in alluvium from mixed rock sources. The alluvium is strongly influenced by shale and volcanic ash. These soils are on old, alluvial fans. Slope ranges from 2 to 15 percent. The vegetation is big sagebrush, squirreltail, and scattered juniper trees. Elevation is 5,800 to 6,200 feet. Average annual precipitation is 8 to 10 inches, average annual air temperature is 44° to 46°F, and the frost-free season is 70 to 100 days.

In a representative profile the surface layer is variegated light gray, light brownish gray and pale brown gravelly clay loam about 4 inches thick. Below this is very pale brown, brown, yellowish brown, and light yellowish brown gravelly clay about 13 inches thick. Next is a pale brown hardpan about 12 inches thick. Below the hardpan, to a depth of 60 inches, is light gray and very pale brown very gravelly sand that is weakly cemented in thin strata and pockets and contains common, hard and very hard, cylindrical nodules. Permeability is slow. Effective rooting depth is 12 to 20 inches. Available water capacity is very low.

Representative profile of Ratto gravelly fine sandy loam, 2 to 8 percent slopes, in Eureka County, 1,550 feet east of the southwest corner of sec 21, T. 21 N., R. 54E.:

- A1 - 0 to 3 inches; variegated light gray (10YR 7/2), light brownish gray (10YR 6/2) and pale-brown (10YR 6/3) gravelly fine sandy loam, dark yellowish brown (10YR 3/4) moist; weak medium platy structure; soft, very friable, nonsticky and nonplastic; few very fine roots; many interstitial pores; 15 percent gravel; neutral; abrupt irregular boundary.
- B1 - 3 to 7 inches; variegated light gray (10YR 7/2), light brownish gray (10YR 6/2) and pale brown (10YR 6/3) gravelly clay loam dark yellowish brown (10YR 4/4) moist; weak thin and very thin platy structure; slightly hard, friable, sticky and plastic; sommon fine, very fine, medium, and coarse roots; few fine and many very fine interstitial pores; 15 percent gravel; neutral; abrupt broken boundary.
- B21t- 7 to 12 inches; very pale brown (10YR 7/2) and brown (10YR 5/3) gravelly clay, dark yellowish brown (10YR 4/4) moist; strong medium prismatic structure; hard, firm, very sticky and very plastic; common fine, very fine, medium, and coarse roots; common fine and very fine interstitial pores; 15 percent gravel; common moderately thick clay films on peds and in pores; neutral; clear smooth boundary.
- B22t-12 to 20 inches; yellowish brown (10YR 5/4) and light yellowish-brown (10YR 6/4) gravelly clay, dark yellowish-brown (10YR 4/4) moist; moderate coarse angular blocky structure; hard, firm, very sticky and very plastic; few roots; few fine and very fine tubular and interstitial pores; 30 percent gravel; common thin and moderately thick clay films in pores and on peds; effervescent on a few small flecks of pan material in lower part; neutral; abrupt smooth boundary.
- Clsicam-20 to 34 inches; very pale brown (10YR 8/3 and 7/3) duripan, dark grayish brown (10YR 4/2) and dark brown (10YR 4/3) moist; massive; strongly cemented matrix is very hard and extremely hard; very firm and extremely firm, with common very thin (2 millimeters or less) continuous indurated silica laminae; few fine and very fine interstitial pores; coarse fragments coated with silica and lime; extremely hard cylindrical silica-lime nodules; violently effervescent; strongly alkaline; abrupt smooth boundary.

IICsica-34 to 60 inches; light gray (10YR 7/2) and very pale brown (10YR 7/3) very gravelly sand, brown to dark brown (10YR 4/3) and dark grayish brown (10YR 4/2) moist; massive and single grained; very hard and loose, firm and loose, non-sticky and nonplastic; many very fine interstitial pores; 80 percent gravel; weakly cemented in thin strata and pockets; common hard to very hard cylindrical durinodes 1/2 to 1 inch in diameter; many medium distinct white (10YR 8/2) lime masses; violently effervescent; strongly alkaline.

Texture of the A horizon is gravelly fine sandy loam, very fine sandy loam, silt loam, silt, or light clay loam. The upper 7 inches of the profile has platy or granular structure and is soft or slightly hard when dry. The B2t horizon has prismatic or angular blocky structure. It is heavy clay loam or clay that is as much as 30 percent gravel. The Csicam horizon is massive and contains indurated lenses that have the appearance of plates. It is moderately alkaline or strongly alkaline, and strongly or violently effervescent. The IIC horizon is unconformable very gravelly or cobbly sand and loamy sand.

2.3 Individual Soils and Soil Associations

In this section, individual soils and soil associations are discussed in detail. Each soil or soil association is stated, including its corresponding map unit symbol. Soil data were obtained from the Soil Survey of Diamond Valley Area (SCS, 1980) and another survey by Soil and Land Use Technology, Inc. (1980) for the Antelope Valley - Roberts Mountain area.

2.3.1 Alhambra fine sandy loam, hummocky - AbC

A well drained, deep soil derived from mixed rock sources and with admixtures of loess that is high in volcanic ash. This nearly level soil is in irregularly shaped areas on old flood plains. Slope ranges from 0 to 2 percent. A distinctive windblown accumulation of fine sandy loam in hummocks 2 to 8 feet high is characteristic of this soil. Included in mapping of this soil

and making up about 15 percent of the acreage, are areas of Shipley and Kobeh soils and areas of sand dunes.

Permeability is moderately rapid and available water capacity is moderate. Runoff is slow and the hazard of wind erosion is moderate. Mean annual precipitation is 8 to 10 inches and the mean annual soil temperature is 43°F.

This soil, if leveled, is suited to irrigated crops. It is used for livestock grazing and wildlife habitat.

2.3.2 Atrypa Association - AT

Shallow and well drained soils formed in residuum from soft shale that have minor amounts of limestone, dolomite, and conglomerate. They are moderately sloping to moderately steep soils, found in irregularly shaped areas of medium size on foothills. It is about 60% Atrypa gravelly loam that has slopes of 15% to 30%, and about 30% Atrypa loam that has slopes of 4% to 15%. Included with this association in mapping, and making up about 10% of the acreage, are other Atrypa soils. Runoff is rapid on the Atrypa gravelly loam and medium on the Atrypa loam. The hazard of erosion is severe on the Atrypa gravelly loam and moderate on the Atrypa loam. The mean annual precipitation is about 14 inches and the mean annual soil temperature is 43° to 46°F. Permeability is moderate and the available water capacity is low. The main uses are for livestock grazing and wildlife habitat.

2.3.3 Atrypa-Mau Association - 831

Shallow to moderately deep, well drained soils. The Atrypa soil formed in residuum and colluvium from soft shale, and has minor amounts of limestone, dolomite and conglomerate rock. The Mau soil formed in residuum and colluvium from andesite and basalt. The association forms moderately sloping to moderately steep soils; 4% to 30% slopes for the Atrypa soil and 15% to 30% slopes for the Mau soil, and is found in irregularly shaped areas of medium size on foothills and mountains. Composition is 75% Atrypa soil and

10% Mau soil. Included and mapped with the association and making up 15% of the acreage, are Hayeston soil, rock outcrop and Xerollic Haplargids.

Texture of the association is loamy to stony loam with medium to rapid runoff and the hazard of erosion moderate to severe. Mean annual precipitation is about 13 inches and the mean annual soil temperature is 45° F. Permeability is moderate for the Atrypa soil and slow to moderately slow for the Mau soil. Both have low available water capacities.

The Atrypa-Mau association is unsuitable for irrigated crops. Primary use is for livestock grazing and wildlife habitat.

2.3.4 Bruffy - Br

A well drained, deep soil that formed in moderately fine textured alluvium derived from mixed parent rocks. This nearly level soil is found in long, narrow, meandering areas on the lowest portions of the flood plains. Slope ranges from 0 to 2 percent. Included with this soil in mapping, and making up about 20 percent of the acreage, are areas of Shipley, Alhambra, Kobeh and other Bruffy soils.

Permeability is moderate and available water capacity is moderate. Runoff is slow and the hazard of erosion is slight. The soil is susceptible to occasional overflow. Mean annual precipitation is 8 to 10 inches and the mean annual soil temperature is 44°F.

The Bruffy silt loam is mainly used for cultivated crops, livestock grazing and wildlife habitat.

2.3.5 Chad-Cleavage-Softscrabble Association - 681

These are well drained soils found on foothills, mountains and mountain ridges ranging from shallow to very deep. The Chad and Cleavage soils formed in residuum from weathered chert and shale, while the Softscrabble soil formed in colluvium and residuum from weathered volcanic rock. Slopes are 15% to 50% for the Chad and Softscrabble soils and 8% to 30% for the Cleavage

soil. Typical textures of the Chad-Cleavage-Softscrabble association are cobbly loam, gravelly loam and stony fine sandy loam, respectively.

Composition of the association is 45% Chad soil, 20% Cleavage soil and 20% Softscrabble soil. Other soils mapped with the association are Welch loam, Walti stony loam and rock outcrop, composing 15% of the acreage.

Runoff is rapid to medium and the hazard of erosion moderate to severe. Mean annual precipitation is about 15 inches and the mean annual soil temperature is 43° to 46° F. Permeability is moderate to moderately slow and the available water capacity is very low.

Mainly used for livestock grazing and wildlife habitat.

2.3.6 Decan-Coils Association - 222

An association of well drained soils that are moderately deep. The Decan soil formed in mixed alluvium and the Coils soil formed in mixed alluvium from volcanic and sedimentary rocks. The association forms gently sloping to strongly sloping soils; 8 to 15 percent slopes for the Decan soil and 2 to 15 percent slopes for the Coils soil; found on strongly dissected outwash fan remnants at the upper limits of the basin valley fill parapediments. Composition is 60% Decan stony loam, 25% Coils loam, 5% Xerollic Camborthids, 5% Haploxerollic Durorthids and 5% Xerollic Durargids.

Permeability is slow to moderate and the available water capacity is very low. Runoff is medium and the hazard of erosion is slight. The mean annual precipitation is 10 to 12 inches and the mean annual soil temperature is 45° to 47°F.

Primary use for the Decan-Coils association is for livestock grazing and wildlife habitat.

2.3.7 Dianev - DN

A moderately well drained to somewhat poorly drained, deep soil derived from alluvium and lacustrine material of mixed rock sources. This soil is nearly level and found in elongated areas of large and moderate size around and parallel to the sides of the playa on low lake terraces. Slopes range from 0 to 2 percent. Included with this soil in mapping and making up about 15 percent of the acreage, are areas of Alhambra, Playas and other Dianev soils.

Permeability is slow or very slow and the available water capacity is high. Runoff is slow and the hazard of erosion is slight. A seasonal high water table is at a depth of 3 to 6 feet. Mean annual precipitation is 8 to 10 inches and the mean annual soil temperature is 44° to 47°F.

This soil is suited to irrigated crops and is used mainly for cultivated crops, livestock grazing and wildlife habitat.

2.3.8 Handy (gravelly loam) - HDD

A well drained, very deep soil derived mainly from alaskite but influenced by limestone and dolomite. Slopes are 4% to 15% and the soil is in large, irregularly shaped areas on old alluvial fans. Runoff is medium and the hazard of erosion is moderate. Permeability is slow and the available water capacity is moderate. Mean annual precipitation is 8 to 12 inches and the mean annual soil temperature is 45° to 47°.

The soil is not suited to irrigated crops and is used mainly for livestock grazing and wildlife habitat.

2.3.9 Handy (loam, 2-8 percent slopes) - 922

A well drained, deep soil formed from gravelly alluvium derived from extrusive volcanic rocks, quartzite and chert. Slopes are 2 to 8 percent. This soil is found on gently to moderately sloping, slightly dissected, old, coalescent outwash fans and fill plain terrace remnants. The composition is 85 percent Handy loam, 2-8 percent slopes; 8 percent Welch loam, drained, 0 to 2

percent slopes; 3 percent Jesse Camp silt loam, 0 to 2 percent slopes; and 4 percent Fertaline gravelly loam, 4 to 15 percent slopes.

Permeability is slow and the available water capacity is moderate. Runoff is slow and the hazard of erosion slight. Mean annual precipitation is 12 inches and the mean annual soil temperature is 45° to 47°F.

This soil is not suited to irrigated crops. Primary uses are for livestock grazing and wildlife habitat.

2.2.10 Hayeston-Silverado Association - HE

Well drained very deep soils derived from mixed volcanic and sedimentary rock. The Hayeston soil is derived from limestone, dolomite and some basalt. The Silverado soil is derived from mixed rock sources with a high content of siliceous material. The soils are in long, narrow strips that follow the old shoreline on lake terraces and beaches. The composition is about 50% Hayeston gravelly fine sandy loam that has slopes of 2% to 4% and about 30% Silverado sandy loam, 2% to 4% slopes. The Hayeston soil is on slightly lower positions while the Silverado soil is on slightly higher positions. Also mapped with these soils, and making up 20% of the acreage, are areas of Shipley, Nayped and Umil soils.

Runoff is medium on the Hayeston soil and slow or medium on the Silverado soil. The hazard of erosion is slight on the Hayeston soil and slight to moderate on the Silverado soil. Permeability is moderately rapid for both soils and the available water capacity is low for both soils. Mean annual precipitation is about 10 inches and the mean annual soil temperature is about 45° to 47°F.

Primary uses are for irrigated crops, livestock grazing and wildlife habitat.

2.3.11 Hopeka-Sheege Association - HS

An association of well drained to excessively drained, very shallow to shallow soils. The Hopeka soils formed in residuum from dolomite and the Sheege soil formed in residuum from limestone and dolomite. The association comprises moderately steep to very steep soils in large, elongated areas on mountains. It is about 60% Hopeka very gravelly loam that has slopes of 15% to 50% and about 30% Sheege very cobbly loam that has slopes of 30% to 75%. The Hopeka soils is on lower positions and have south and west facing slopes. The Sheege soil has north facing, higher, and steeper slopes and a dark-colored surface layer. Included in mapping of this association are areas of rock outcrop, making up 10% of the acreage.

Permeability is moderate and available water capacity is very low. Runoff is medium to rapid and the hazard of erosion is high. Mean annual precipitation is 15 inches and the mean annual soil temperature is 43° to 47° for the Hopeka soil and 36° to 45° for the Sheege soil.

The soils are not suited to irrigated crops and are used mainly for livestock grazing and wildlife habitat.

2.3.12 Kobeh (sandy loam) - Kba

A very deep, well drained soil that formed in alluvium from limestone and sandstone but has some influence from andesite and volcanic ash. Slopes are 0% to 2%. The soil is in irregularly shaped areas of large and medium size that are generally elongated in a north-south direction on old flood plains. Permeability is rapid and available water capacity is low.

Runoff is slow, and the hazard of erosion is slight. Mean annual precipitation is 8 to 10 inches and the mean annual soil temperature is 44° to 47°.

Primary uses are for alfalfa hay, pasture, and small grain. If not cultivated, it is used for livestock grazing and wildlife habitat.

2.3.13 Kobeh (gravelly sandy loam, 0 to 2 percent slopes) - KgA

A very deep, well drained soil that formed in alluvium from limestone and sandstone but has some influence from andesite and volcanic ash. Slopes are 0 to 2 percent. The soil is in irregularly shaped areas of large and medium size that are elongated in a north-south direction on old flood plains. Included in mapping of this soil and making up about 15 percent of the acreage, are areas of Alhambra soils, other Kobeh soils, and a loamy fine sand in long, narrow, wind-formed ridges 1 to 3 feet high.

Permeability is rapid and the available water capacity is low. Run-off is slow and the hazard of erosion is slight. Mean annual precipitation is 8 to 10 inches and the mean annual soil temperature is 43°F.

This soil is used mainly for alfalfa hay, pasture, small grain, livestock grazing and wildlife habitat.

2.3.14 Labshaft-Locane Association (steep) - LAE

Well drained, shallow soils found on low mountains. The Labshaft soil formed in residuum from siliceous rock, including chert, greenstone and conglomerate. The Locane soil formed in residuum from shale and siliceous conglomerate. The association forms steep soils in large elongated areas. It is about 50% Labshaft very stony loam that has slopes of 30% to 50% and about 30% Locane extremely stony loam that has slopes of 30% to 50%. The Labshaft soil has northeast facing slopes and the Locane soil has southwest facing slopes. Included with these soils in mapping and making up about 20% of the acreage, are areas of Devoy soils, stony to extremely stony soils that are more than 20 to 40 inches deep to bedrock, and rock outcrop.

Permeability is moderate or moderately slow for the Labshaft soil and moderately slow for the Locane soil. Available water capacities for both soils is very low. Runoff is rapid and the hazard of erosion severe. The mean annual precipitation is 10 to 14 inches and the mean annual soil temperature is 44° to 47° F.

The Labshaft-Locane association is not suited to irrigated crops. Primary uses are livestock grazing and wildlife habitat.

2.3.15 Labshaft-Locane Association (very steep) - LAF

Consists of well drained shallow soils. The Labshaft soil formed in residuum from siliceous rocks, including chert, greenstone and conglomerate. The Locane soil formed in residuum from shale and siliceous conglomerate bedrock. The association forms very steep soils in large, elongated areas on mountains. It is about 40% Labshaft very stony loam that has slopes of 50% to 75% and about 40% Locane extremely stony loam that has slopes 50% to 75%. The Labshaft soil has northeast facing slopes, and the Locane soil has southwest facing slopes. Included with these soils in mapping, and making up about 20% of the acreage, are areas of extremely stony loam soils that are more than 20 inches deep to bedrock, and Rock outcrop.

Permeability is moderate or moderately slow for the Labshaft soil, and available water capacity is very low. Permeability is moderately slow and the available water capacity is very low for the Locane soil. Runoff for the association is rapid and the hazard of erosion is severe. Mean annual precipitation is 10 to 14 inches and the mean annual soil temperature is 44° to 47°F.

The soils are not suited to irrigated crops. Primary use is for limited livestock grazing and wildlife habitat.

2.3.16 Labshaft-Rock Outcrop Complex - LK

The Labshaft soils is well drained and shallow. It formed in residuum from siliceous rocks, including chert, greenstone and conglomerate.

The complex consists of moderately steep soils and Rock outcrop in large, irregularly shaped areas on hills. It is about 75% Labshaft stony loam that has slopes of 15% to 30% and about 15% Rock outcrop. The Labshaft soil is in areas between the Rock outcrops. The Rock outcrop is small knolls and scarps. Included with this complex in mapping, and making up about 10% of the

acreage, are areas of a stony loam soil that is more than 20 inches deep to bedrock.

Permeability for the Labshaft soil is moderate or moderately slow with a very low available water capacity. Runoff on the Labshaft soil is medium and the hazard of erosion is moderate. Mean annual precipitation is 10 to 14 inches and the mean annual soil temperature is 44° to 47° F.

The complex is not suited to irrigated crops. Primary use is for livestock grazing and wildlife habitat.

2.3.17 Lone - LnB

A very deep, well drained soil formed from parent rock of limestone, sandstone, shale, tuffs, siliceous conglomerate and some volcanic ash. The soil is in irregularly shaped areas of small and medium size on the tops of high lake terraces. Slopes range from 2% to 8%. Commonly, a white silica-lime cemented hardpan occurs at a depth of 30 inches, but in some places the hardpan is at a depth of about 20 inches. Included with this soil in mapping, and making up about 15% of the acreage, are areas of Alhambra and Kobeh soils and other gravelly loams that have discontinuous indurated layers and contain nodules.

Permeability is moderate above the hardpan and the available water capacity is low. Runoff is slow or medium and the hazard of erosion is slight or moderate. Mean annual precipitation is 8 to 10 inches and the mean annual soil temperature is 45° to 48°.

Primary uses are for livestock grazing and wildlife habitat. It is not suited to irrigated crops.

2.3.18 Mau-Shagnasty-Eightmile Association - 321

An association of well drained soils found on the sides of old volcanic cones and flows. The Mau soil is moderately deep, the Shagnasty soil is deep to very deep, and the Eightmile soil is shallow. The Mau soil formed in

residuum and colluvium from andesite and basalt; the Shagnasty soil formed in residuum and colluvium from rhyolite, andesite and quartzite, and the Eightmile soil formed in residuum from shale, sandstone and quartzite. The association forms irregularly shaped areas of medium size on moderately steep uplands. All three soils have slopes of 15% to 30%. Composition of the association is 45% Mau soil, 30% Shagnasty soil and 15% Eightmile soil. Included with the association in mapping, and making up 10% of the acreage, are areas of Xerollic Camborthids, Welch loam and Lithic Haplargids soils.

Permeability is moderate to moderately slow and the available water capacity is low. Runoff is medium to rapid and the hazard of erosion severe. Mean annual precipitation is 14 inches and the mean annual soil temperature is 44° to 46°F.

Primary uses are for livestock grazing and wildlife habitat; not suited to irrigated crops.

2.3.19 Ratto - RAC

A deep, well drained soil that formed in alluvium from mixed rock sources, and is strongly influenced by shale and volcanic ash. A hardpan occurs at a depth of 17 inches from the surface. Commonly, a gently sloping to moderately sloping soil in irregularly shaped areas of medium size on lower parts of old alluvial fans. Included with this soil in mapping, and making up about 15% of the acreage, are areas of Pedoli and Holtle soils and soils that are similar to this Ratto soil but are more than 20 inches deep to the hardpan.

Permeability is slow and the available water capacity is very low. Runoff is slow and the hazard of erosion is slight. Mean annual precipitation is 8 to 10 inches and the mean annual soil temperature is 46° to 48° F.

Primary uses are for livestock grazing and wildlife habitat. Much of this soil has been seeded to crested wheatgrass. It is not suited to irrigated crops.

2.3.20 Rock Outcrop

This term is used to describe miscellaneous land types consisting of surface exposures of bedrock. Rock outcrop is defined here in the soil description text because it is included in the mapping of various soils, and makes up a certain percentage of the acreage.

Rock outcrop occurs throughout the uplands. A wide variety of rocks are included, but andesite, basalt, rhyolite, tuff, dacite, sandstone, and limestone are dominant. Included with Rock outcrop are other small areas of soils that are less than 4 inches deep over bedrock. Rock outcrop is on nearly level to extremely steep exposures, and it generally supports little or no vegetation, except in a few pockets of intervening soils or in fractures of the rock. Runoff is very rapid, and the hazard of erosion is slight.

These areas have value mainly for wildlife habitat, recreation, watershed, or esthetic uses.

2.3.21 Rubyhill - RHC

A well drained, deep soil that formed in alluvium dominantly from limestone and quartzite. Slopes range from 2 to 8 percent. This gently sloping to moderately sloping soil is in irregularly shaped areas of large and medium size on old, dissected alluvial fans. Included in the mapping of this soil and making up about 20 percent of the acreage, are areas of other Rubyhill and Ratto soils.

Permeability is moderate and the available water capacity is low. Runoff is slow and the hazard of erosion is slight. Mean annual precipitation is 8 to 12 inches and the mean annual soil temperature is 44° to 47°F.

The soil has limited suitability for alfalfa or small grain. Primary uses are for irrigated crops, livestock grazing and wildlife habitat.

2.3.22 Shagnasty-Roca-Rock Association - 764

An association of well drained soils that formed in residuum from andesite, rhyolite and quartzite. The Shagnasty soil is deep to very deep with slopes of 15% to 50%. The Roca soil is deep with slopes of 15% to 30%. The association is found on steep mountain and hill slopes and has a composition of 45% Shagnasty soil, 25% Roca soil and 15% Rock outcrop. Included with the association in mapping, and making up 15% of the acreage, are areas of Welch loam, Walti stony loam and Lithic Argixerolls.

Permeability is moderately slow for the Shagnasty soil and very slow for the Roca soil. Available water capacity for both soils is very low. Run-off is rapid and the hazard of erosion severe. The mean annual precipitation is 13 inches and the mean annual soil temperature is 44° to 46° F.

Neither soils in the association are suited to irrigated crops. Primary use is for livestock grazing and wildlife habitat.

2.3.23 Shipley (silt loam, 0 to 2 percent slopes) - ShA

A very deep, well drained soil that formed in loamy alluvium and lacustrine material from mixed rock sources. This soil is nearly level and found in irregularly shaped areas of small and medium size on flood plains. Included in the mapping of this soil and making up about 15 percent of the acreage, are areas of Kobeh and Alhambra soils. Also included are areas of a silt loam similar to this Shipley soil but that has a dark surface layer 2 to 8 inches thick.

Permeability is moderate and the available water capacity is high. Runoff is slow and the hazard of erosion is slight. Mean annual precipitation is 8 to 10 inches and the mean annual soil temperature is 45° to 47°F.

This soil is suited to irrigated crops. Primary uses are for irrigated crops, livestock grazing and wildlife habitat.

2.3.24 Shipley (silt loam, moderately saline - alkali, 0-2 percent slopes)
- S1A

A very deep, well drained soil that formed in loamy alluvium and lacustrine material from mixed rock sources. This soil is in large, irregularly shaped areas and alluvial fans. The upper 10 to 16 inches are moderately saline-alkali affected. Included with this soil in mapping and making up about 10 percent of the acreage, are areas of Alhambra and Kobeh soils.

Permeability is moderate and the available water capacity is high. Runoff is slow and the hazard of erosion is slight. A seasonal high water table is at a depth of 3.5 feet to 5 feet. Mean annual precipitation is 8 to 10 inches and the mean annual soil temperature is 45° to 47°F.

This soil is suitable to irrigated crops if reclaimed. Primary uses are livestock grazing and wildlife habitat.

2.3.25 Shipley (silt loam, 0-2% slopes, occasionally flooded) - SMA

A very deep, well drained soil that formed in loamy alluvium and lacustrine material from mixed rock sources. Silty material is often deposited on the surface of the soil. The soil is in large, irregular areas on alluvial fans. Because of a susceptibility to overflow, the soil is occasionally flooded. Included with the Shipley soil in mapping, and making up about 15% of the acreage, are areas of Dianev soils and areas of other Shipley soils that are not flooded.

Permeability is moderate and the available water capacity is high.

Runoff is slow and the hazard of erosion is slight. Mean annual precipitation is about 8 to 10 inches and the mean annual soil temperature is 45° to 47° F.

Shipley soil is suited to irrigated crops, however, it is used mainly for livestock grazing and wildlife habitat.

2.4 Soils of Proposed and Alternative Component Areas

This section has been provided to describe the soil associations along the proposed access road, highway relocation, water line, power line and tailings pond sites, as well as any alternatives thereof.

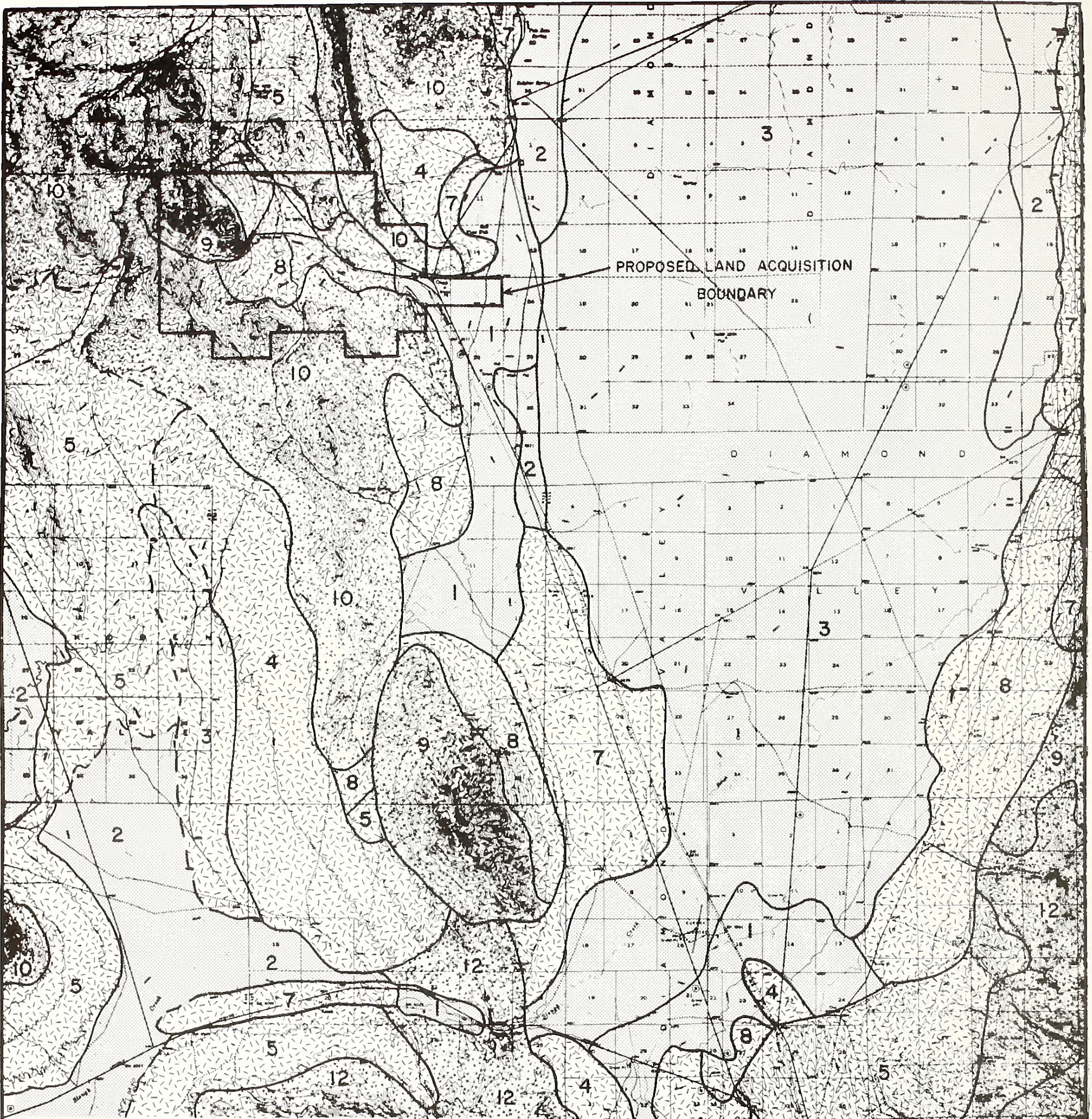
All descriptions have been taken from the Soil Survey of Diamond Valley Area (SCS, 1980). The survey characterizes soils in terms of three physiographic units: (1) Old Lake Bottoms, Old Flood Plains, Low Lake Terraces, and Recent Alluvial Fans; (2) Old Alluvial Fans, Terraces, Pediments and Foothills; and (3) Hills and Mountains.

The soils within the three physiographic units and the various soil associations along the proposed and alternative components are keyed numerically to a regional soils map (Figure 2-2). The map is of a very generalized nature, showing areas dominated by a particular soil association, and is not a basis for decisions on the use of specific tracts. Each outlined area consists of more than one kind of soil. Data for Figure 2-2 was taken from the SCC (1980) and Soil and Land Use Technology, Inc. (1980). Tables 3-2, 3-3 and 3-4 (Section 3.1) list the soil associations identified by map overlay along the proposed and alternative components.

2.4.1 Soils of Old Lake Bottoms, Old Flood Plains, Low Lake Terraces, and Recent Alluvial Fans

These soils formed in alluvium from a wide variety of parent rock. The surface layer is moderately coarse textured, medium textured, or moderately fine textured. These soils are somewhat excessively drained to somewhat poorly drained, generally calcareous, and moderately alkaline to strongly alkaline.

The Nayped-Shipley association is on local alluvial fans and lake terraces just above the valley flood plains. The Kobeh-Alhambra association is in intermediate position on the valley flood plains and on the alluvial fans. The Playas-Dianev association is in the lowest position, on the valley bottom.



LEGEND

SOILS OF OLD LAKE BOTTOMS, OLD FLOOD PLAINS, LOW LAKE TERRACES AND RECENT ALLUVIAL FANS

- 1** Nearly level and gently sloping, well drained, very deep soils; on alluvial fans and lake terraces
- 2** Playas and nearly level, somewhat poorly drained, very deep soils; on old lake bottoms and low lake terraces
- 3** Nearly level and gently sloping, somewhat excessively drained and well drained, very deep soils; on old flood plains and toe slopes of alluvial fans

SOILS OF OLD ALLUVIAL FANS, TERRACES, PEDIMENTS AND FOOTHILLS

- 4** Nearly level to moderately sloping, well drained soils that are moderately deep to a hardpan; on old alluvial fans
- 5** Gently sloping to steep, well drained soils that are shallow to a hardpan; on old alluvial fans and terraces
- 6** Moderately steep, well drained, very deep and moderately deep soils; on old dissected fans, pediments and foothills
- 7** Nearly level to strongly sloping, well drained, very deep soils; on old lake terraces and alluvial fans
- 8** Gently sloping to strongly sloping, well drained soils that are shallow to a hardpan or are very deep; on old alluvial fans and lake terraces

SOILS OF THE HILLS AND MOUNTAINS

- 9** Strongly sloping to steep, well drained, deep and moderately deep soils; on mountains and hills
- 10** Moderately steep to very steep, well drained to excessively drained, shallow soils; on mountains and hills
- 11** Steep and very steep, well drained, shallow and moderately deep soils; on mountains
- 12** Moderately sloping to very steep, well drained, moderately deep and shallow soils; on mountains and foothills

- Soil Boundary
- - - Inferred Soil Boundary



*** NOTE :** THIS IS A GENERAL SOILS MAP. EACH OUTLINED AREA ON THIS MAP CONSISTS OF MORE THAN ONE KIND OF SOIL.

SOURCE: Modified from SCS data(1980) and Soil and Land Use Technology, Inc. data (1980).

BASE: USGS TOPO QUADRANGLES, GARDEN VALLEY, WHISTLER MTN., DIAMOND SPRINGS & EUREKA, NEVADA.

0 1 2 3 4 5 Miles

0 1 2 3 4 5 6 7 8 Km.

MT. HOPE MOLYBDENUM PROJECT

REGIONAL SOILS MAP

U.S. Department of the Interior
Bureau of Land Management

FIGURE

2-2

2.4.1.1 Nayped-Shipley Association (1)

Nearly level and gently sloping, well drained, very deep soils; on alluvial fans and lake terraces. The Nayped-Shipley association is on alluvial fans and lake terraces around the margin of the floor of Diamond Valley. Elevation is 5,800 to 6,200 feet. Average annual precipitation is 8 to 10 inches, average annual temperature is 42° to 46°F, and the frost-free season is about 70 to 100 days.

Nayped soils make up about 45 percent of the association and Shipley soils 35 percent; the remaining 20 percent is Holtle, Kobeh, Lone, and Alhambra soils.

Nayped soils are on alluvial fans. They are well drained. Typically, they have a surface layer of light brownish gray and brown loam about 7 inches thick. The next layer is pale brown loam about 9 inches thick. Below this is stratified very pale brown, pale brown, light gray, and light yellowish brown loam and very fine sandy loam that contain a few silica-lime cemented nodules. The plant cover is mainly big sagebrush.

Shipley soils are on alluvial fans and lake terraces. They are well drained. Typically, the upper 18 inches of the profile is light brownish gray and light gray silt loam. Below this, to a depth of 60 inches, is light gray very fine sandy loam. The plant cover is mainly common winterfat and big sagebrush.

This association is used for irrigated crops, livestock grazing, and food and cover for wildlife. Additional areas can be irrigated if water is available. These soils are suited to range seeding.

2.4.1.2 Playas-Dianev Association (2)

Playas and nearly level, somewhat poorly drained very deep soils; on old lake bottoms and low lake terraces. The Playas-Dianev association is on old lake bottoms and adjacent low lake terraces. Elevation is 5,770 to 6,020 feet. Average annual precipitation is 8 to 10 inches, average annual

temperature is 43° to 46°F, and the frost-free season is about 70 to 100 days.

Playas make up about 40 percent of the association and Dianv soils about 40 percent; the remaining 20 percent is Nevka, Vinsad, Sader, and Bicondoa soils.

Playas are low-lying basins on old lake bottoms. They are intermittently ponded. The Playas consist of stratified clay, silty clay and silty clay loam. They are essentially barren.

Dianeve soils are on low lake terraces. They are somewhat poorly drained. Typically, they are light gray silty clay loam to a depth of more than 60 inches. Plant cover is mainly greasewood, inland saltgrass, and rubber rabbitbrush.

This association is used mainly for livestock grazing and food and cover for wildlife. A small acreage of Dianeve soils is used for meadow hay. These soils are generally not suited to irrigated crops, but small areas have limited suitability if water is available.

2.4.1.3 Kobeh-Alhambra Association

Nearly level and gently sloping, somewhat excessively drained and well drained, very deep soils; on old flood plains and toe slopes of alluvial fans in the southcentral part of the Area. Elevation is 5,800 to 6,100 feet. Average annual precipitation is 8 to 10 inches, average annual temperature is 41° to 45°F, and the frost-free season is about 70 to 100 days.

Kobeh soils make up about 50 percent of the association and Alhambra soils about 35 percent; the remaining 15 percent is Bruffy, Hamacer, Tonkin, and Shipley soils.

Kobeh soils are on old flood plains and alluvial fans. They are somewhat excessively drained. Typically, they have a surface layer of grayish brown sandy loam and light brownish gray fine sandy loam about 7 inches thick.

The next layer is pale brown gravelly fine sandy loam about 10 inches thick. Below this is stratified gravelly sandy loam that contains a few silica-lime cemented nodules and very gravelly sand. The plant cover is mainly big sagebrush.

Alhambra soils are on old flood plains, alluvial fans, and terraces. They are well drained. Typically, the upper 15 inches of the profile is light gray and light brownish gray fine sandy loam that contains a few silica-lime cemented nodules. Below this is stratified light gray gravelly sand and coarse sand. The plant cover is mainly big sagebrush, shadscale, and bud sagebrush.

This association is used mainly for irrigated crops, livestock grazing, and food and cover for wildlife. Additional areas can be irrigated if water is available. The soils are suited to range seeding and are a potential source of sand and gravel.

2.4.2 Soils of Old Alluvial Fans, Terraces, Pediments, and Foothills

These soils formed in local alluvium and residuum from a wide variety of parent rock. The surface layer is moderately coarse textured to fine textured and in places contains gravel. These soils are well drained. They are shallow to moderately deep over a silica-lime cemented hardpan, or they are deep over sand and gravel.

The Rubyhill and Ratto-Handy-Pedoli associations are on alluvial fans. The Umil-Bobs and Silverado-Hayeston-Credo associations are on the alluvial fans and lake terraces. The Ridit-Alpha and Fairydell-Gabel associations are on alluvial fans and foothills.

2.4.2.1 Rubyhill Association (4)

Nearly level to moderately sloping, well drained soils that are moderately deep to a hardpan; on old alluvial fans. The Rubyhill association is on old alluvial fans along the sides of valley. Elevation is 5,900 to 6,300 feet. Average annual precipitation is 8 to 12 inches, average annual

temperature is 42° to 45°F, and the frost-free season is about 70 to 100 days.

Rubyhill soils make up about 94 percent of the association; the remaining 5 percent is Kobeh, Shipley, and Umil soils.

Rubyhill soils are well drained. Slope is 0 to 8 percent. Typically, they have a surface layer of light brownish gray fine sandy loam about 4 inches thick. The next layer is pale brown loam about 17 inches thick. Below this is a very pale brown, silica-lime cemented hardpan. The plant cover is mainly big sagebrush and Sandberg bluegrass.

This association is used mainly for livestock grazing and food and cover for wildlife. The soils are suited to irrigated crops if water is available. They are suited to range seeding.

2.4.2.2 Umil-Bobs Association (5)

Gently sloping to well drained soils that are shallow to a hardpan; on old alluvial fans and terraces. The Umil-Bobs association is on old alluvial fans and terraces in the southern and western parts of the survey area. Elevation is 6,000 to 6,600 feet. Average annual precipitation is 8 to 12 inches, average annual temperature is 42° to 45°F, and the frost-free season is about 70 to 100 days.

Umil soils make up about 75 percent of the association and Bobs soils 15 percent, the remaining 10 percent is Mau, Ratto, Holtle, and Hayeston soils.

Umil soils are on old alluvial fans and terraces. Slopes are dominantly 2 to 15 percent, but range to 50 percent. The soils are well drained. Typically, the upper 11 inches of the profile is light brownish gray and light gray loam. Below this is a white, silica-lime cemented hardpan. The plant cover is mainly black sagebrush, squirreltail, and Sandberg bluegrass.

Bobs soils are on old alluvial fans and terraces. Slopes are 4 to 15 percent. The soils are well drained. Typically, the surface layer is grayish brown gravelly loam about 4 inches thick. The next layer is pale brown and very pale brown gravelly loam about 15 inches thick. Below this is a white, indurated, lime-cemented hardpan. The plant cover is mainly an open stand of pinyon and juniper and an understory of big sagebrush, squirreltail, Sandberg bluegrass, black sagebrush, and bitterbrush.

This association is used mainly for livestock grazing and food and cover for wildlife.

2.4.2.3 Fairydell-Gabel Association (6)

Moderately steep, well drained, very deep and moderately deep soils; on old dissected fans, pediments, and foothills. The Fairydell-Gabel association is on old alluvial fans, pediments, and foothills in the southern part of the survey area. Elevation is 6,300 to 8,00 feet. Average annual precipitation is 10 to 16 inches, average annual temperature is 43° to 47°F, and the frost-free season is about 50 to 100 days.

Fairydell soils make up about 70 percent of the association and Gabel soils about 15 percent; the remaining 15 percent is Holtle and Hussa soils and areas of Badland.

Fairydell soils are on old, dissected alluvial fans and pediments. Slopes are 15 to 30 percent. The soils are well drained. Typically, the upper 23 inches of the profile is dark grayish brown, light yellowish brown, and pale brown gravelly loam. Below this, to a depth of more than 60 inches, is pale brown very gravelly loam. The plant cover is mainly big sagebrush, Great Basin wildrye, and bluebunch wheatgrass.

Gabel soils are on foothills. Slopes are 15 to 30 percent. The soils are well drained. Typically, the surface layer is grayish brown gravelly loam about 7 inches thick. The next layer is pale brown very gravelly sandy clay loam about 8 inches thick. Below this is very gravelly coarse sandy loam about 9 inches thick. Soft tuff bedrock is at a depth of 24 inches.

The plant cover is mainly big sagebrush, bitterbrush, Great Basin wildrye, and bluebunch wheatgrass.

This association is used mainly for livestock grazing and food and cover for wildlife.

2.4.2.4 Silverado-Hayeston-Credo Association (7)

Nearly level to strongly sloping, well drained, very deep soils; on old lake terraces and alluvial fans. The Silverado-Hayeston-Credo association is on old lake terraces and alluvial fans on the margin of the valley floor throughout the area. Elevation is 5,800 to 6,300 feet. Average annual precipitation is 8 to 12 inches, average annual temperature is 42° to 46°F, and the frost-free season is about 70 to 100 days.

Silverado soils make up about 50 percent of the association, Hayeston soils 20 percent, and Credo soils about 15 percent; the remaining 15 percent is Rito and Lone soils.

Silverado soils are on old lake terraces and alluvial fans. Slopes range from 0 to 15 percent but are dominantly 0 to 4 percent. The soils are well drained. Typically, the surface layer is grayish brown and light brownish gray gravelly loamy coarse sand and sandy loam about 6 inches thick. The next layer is brown sandy loam about 7 inches thick. Below this is pale brown and light brownish gray, weakly silica-cemented gravelly sandy loam about 19 inches thick. This is underlain by light gray gravelly coarse sand. The plant cover is mainly big sagebrush.

Hayeston soils are on low lake terraces. Slopes are 2 to 4 percent. They are well drained. Typically, the upper 31 inches of the profile is pale brown gravelly fine sandy loam. The next 11 inches is very pale brown gravelly loamy fine sand. Below this is multicolored sand and gravel. The plant cover is mainly big sagebrush, Nevada bluegrass, and Great Basin wildrye.

Credo soils are on high and intermediate lake terraces. Slopes are 2 to 8 percent. The soils are well drained. Typically, the surface layer is

grayish brown and light brownish gray gravelly loam and loam about 6 inches thick. The next 18 inches is pale brown loam over pale brown light clay loam. The underlying layer is pale brown, weakly silica-lime cemented gravelly sandy clay loam over very cobbly coarse sandy loam. The plant cover is mainly big sagebrush, squirreltail, and Great Basin wildrye.

This association is used mainly for livestock grazing and food and cover for wildlife. The Credo and Silverado soils are suited to irrigated crops if water is available. The soils are suited to range seeding. The Hayeston and Silverado soils are also a potential source of sand and gravel.

2.4.2.5 Ratto-Handy-Pedoli Association (8)

Gently sloping to strongly sloping, well drained soils that are shallow to a hardpan or are very deep; on old alluvial fans and lake terraces. The Ratto-Handy-Pedoli association is on old alluvial fans and lake terraces that surround Diamond Valley, mainly in the southern half of the survey area. Elevation is 6,000 to 6,400 feet. Average annual precipitation is 8 to 12 inches, average annual temperature is 43° to 47°F, and the frost-free season is about 70 to 100 days.

Ratto soils make up about 50 percent of the association, Handy soils 25 percent, and Pedoli soils about 15 percent; the remaining 10 percent is Credo and Stampede soils.

Ratto soils are on old alluvial fans. Slopes are 20 to 15 percent. The soils are well drained. Typically, the surface layer is light gray, light brownish gray, and pale brown gravelly fine sandy loam about 3 inches thick. Below this is pale brown, brown, and yellowish brown gravelly clay loam and gravelly clay about 17 inches thick. This is underlain by a very pale brown, silica-lime cemented hardpan. The plant cover is mainly big sagebrush, squirreltail, and scattered juniper.

Handy soils are on old alluvial fans. Slopes are 4 to 15 percent. The soils are well drained. Typically, the surface layer is pale brown gravelly loam about 4 inches thick. Below this is brown, yellowish brown, and

very pale brown gravelly clay loam and gravelly clay about 26 inches thick. Below this is very pale brown gravelly fine sandy loam to a depth of 10 inches and more. The plant cover is mainly big sagebrush, squirreltail, and scattered pinyon and juniper.

Pedoli soils are on old alluvial fans and lake terraces. Slopes are 2 to 4 percent. The soils are well drained. Typically, the surface layer is pale brown gravelly fine sandy loam about 6 inches thick. The next layer is light yellowish brown and very pale brown gravelly clay loam about 19 inches thick. Below this is very pale brown gravelly sandy loam and very gravelly loamy sand to a depth of more than 60 inches. The plant cover is mainly big sagebrush, squirreltail, and scattered juniper.

This association is used mainly for livestock grazing and food and cover for wildlife. Pedoli soils are suited to range seeding.

2.4.3 Soils of the Hills and Mountains

These soils formed in residuum and colluvium from sedimentary and igneous rocks. In some places loess overlies these materials. Outcrops of bedrock are common. The surface layer is extremely stony, very stony, very gravelly, or gravelly and medium textured. These soils are well drained and very shallow to moderately deep over bedrock.

All of the associations are on moderately steep to very steep hills and mountains that surround the valley. Elevation ranges from 6,000 to 10,600 feet.

2.4.3.1 Fera-Roca-Devoy Association (9)

Strongly sloping to steep, well drained, deep and moderately deep soils; on mountains and hills. The Fera-Roca-Devoy association is on mountains and hills in the northern part of the Diamond Range, on Richmond Mountain, Whistler Mountain, and Mt. Hope Mountain in the northwestern part of the survey area. Elevation is 6,000 to 8,000 feet. Average annual precipitation

is 8 to 14 inches, average annual temperature is 41° to 46°F, and the frost-free season is about 50 to 100 days.

Fera soils make up about 35 percent of the association, Roca soils 30 percent, and Devoy soils about 20 percent; the remaining 15 percent is Tica and Mau soils and areas of Rock outcrop.

Fera soils are on north-facing mountainsides. Slopes are 15 to 50 percent. The soils are well drained. Typically, the surface layer is grayish brown stony loam and brown very gravelly loam and is about 11 inches thick. Below this is light brown very gravelly clay loam and brown very gravelly clay about 31 inches thick. Conglomerate bedrock is at a depth of about 42 inches. The plant cover is mainly big sagebrush and bluebunch wheatgrass. Pinyon and juniper are in fire protected areas.

Roca soils are on south-facing mountainsides. Slopes are 15 to 50 percent. The soils are well drained. Typically, the surface layer is light brownish gray very stony loam about 4 inches thick. Below this is light brownish gray and gravelly clay loam and brown gravelly clay about 20 inches thick. Shale bedrock is at a depth of about 24 inches. The plant cover is mainly big sagebrush and Sandberg bluegrass. Pinyon and juniper are in fire-protected areas.

Devoy soils are on mountainsides and hillsides. Slopes are 8 to 50 percent. The soils are well drained. Typically, the surface layer is grayish-brown very stony loam and gravelly loam about 12 inches thick. The next layer is light gray, light yellowish brown and yellowish brown very gravelly heavy clay loam and very gravelly clay about 18 inches thick. Alaskite bedrock is at a depth of about 30 inches. The plant cover is mainly pinyon, juniper, big sagebrush, and bluebunch wheatgrass.

This association is used mainly for livestock grazing and food and cover for wildlife.

2.4.3.2 Labshaft-Hopeka Association (10)

Moderately steep to very steep, well drained to excessively drained, shallow soils; on mountains and hills. The Labshaft-Hopeka association is on mountains and hills of the Sulphur Springs Range along the western side of the survey area. Elevation is 6,000 to 8,000 feet. Average annual precipitation is 10 to 14 inches, average annual temperature is 41° to 46°F, and the frost-free season is about 50 to 70 days.

Labshaft soils make up about 45 percent of the association and Hopeka soils 35 percent; the remaining 20 percent is about half Locane soils and half Sheege, Holtle, and Atrypa soils and areas of Rock outcrop.

The Labshaft soils are on mountainsides and hillsides. Slopes are 15 to 75 percent. The soils are well drained. Typically, the surface layer is grayish brown stony and gravelly loam about 12 inches thick. The next layer is yellowish brown gravelly sandy clay loam about 7 inches thick. Conglomerate bedrock is at a depth of about 19 inches thick. The plant cover is mainly pinyon, juniper, big sagebrush, and bluebunch wheatgrass.

Hopeka soils are on mountainsides. Slopes are 15 to 75 percent. The soils are well drained. Typically, the soil is light gray very gravelly loam and gravelly loam about 7 inches thick over dolomite bedrock. The plant cover is mainly juniper.

This association is used mainly for livestock grazing and food and cover for wildlife.

2.4.3.3 Sheege-Fusulina-Croesus Association (11)

Steep and very steep, well drained, shallow and moderately deep soils; on mountains. The Sheege-Fusulina-Croesus association is on the crest of the Diamond Range on the eastern side of the survey area. Elevation 7,000 to 10,600 feet. Average annual precipitation is 12 to 18 inches, average annual temperature is 35° to 45°F, and the frost-free season is less than 50 days.

Sheege soils make up about 50 percent of the association. Fusulina soils 25 percent, and Croesus soils about 15 percent; the remaining 10 percent is Tahquats and Tica soils and areas of Rock outcrop.

Sheege soils are on convex mountainsides. Slopes are 30 to 75 percent. The soils are well drained. Typically, the profile is grayish brown very cobbly loam and very gravelly very fine sandy loam about 17 inches thick over limestone bedrock. The plant cover is mainly pinyon, juniper, black sagebrush, bitterbrush and mountain brome.

Fusulina soils are on mountainsides. Slopes are 30 to 75 percent. The soils are well drained. Typically, the profile is dark brown shaly loam about 12 inches thick over shale bedrock. The plant cover is mainly big sagebrush, bitterbrush, pinyon, juniper, and Great Basin wildrye.

Croesus soils are in concave areas on mountainsides. Slopes are 30 to 50 percent. The soils are well drained. Typically, the upper 9 inches of the profile is dark grayish brown gravelly loam. The next 25 inches is dark brown very gravelly loam. Limestone is at a depth of about 34 inches. The plant cover is mainly big sagebrush, bitterbrush, mountain-mahogany, bluebunch wheatgrass, mountain brome, and Great Basin wildrye.

This association is used mainly for limited livestock grazing and food and cover for wildlife.

2.4.3.4 Bartine-Overland-Atrypa Association (12)

The Bartine-Overland-Atrypa association is on low mountains and hills near Garden Pass and Phillipsburg Mine and throughout the southern parts of the survey area. Elevation is 6,000 to 8,500 feet. Average annual precipitation is 8 to 16 inches, average annual temperature is 42° to 46°F, and the frost-free season is about 50 to 100 days.

Bartine soils make up about 40 percent of the association. Overland soils 30 percent, and Atrypa soils about 15 percent; the remaining 15 percent is Siri soils and areas of Rock outcrop. Bartine soils are on north and east

facing mountainsides. Slopes are 15 to 50 percent. The soils are well drained. Typically, the upper 15 inches of the profile is grayish brown and light brownish gray gravelly loam. The next 17 inches is pale brown very gravelly loam. Limestone bedrock is at a depth of about 31 inches. The plant cover is mainly pinyon, juniper, big sagebrush, low sagebrush, and bluebunch wheatgrass.

Overland soils are on south and west facing mountainsides. Slopes are 15 to 50 percent. The soils are well drained. Typically the surface layer is light brownish gray very gravelly loam and gravelly loam about 8 inches thick. Below this is very pale brown and light gray very gravelly loam about 15 inches thick. Limestone bedrock is at a depth of 22 inches. The plant cover is mainly juniper and pinyon.

Atrypa soils are on foothills and mountainsides. Slopes are 40 to 75 percent. The soils are well drained. Typically, the surface layer is grayish brown loam about 7 inches thick. Below this is brown loam about 6 inches thick. Shale bedrock is at a depth of about 13 inches. The plant cover is mainly big sagebrush, pinyon, and juniper.

This association is used mainly for livestock grazing and food and cover for wildlife.

CHAPTER 3.0

IMPACT ANALYSES

3.1 Introduction

The analysis of potential soils resources impacts was conducted with an emphasis on two major criterion of effects: (1) soil losses directly resultant from project implementation; and (2) the potential for successful reclamation following soil disturbance.

Section 3.2 lists the pertinent assumptions and guidelines to analysis of impact. The analysis of soil losses involved calculation of soil types affected via map planimetry, soil profile review and empirical formulae applications. Soil losses following industrial purpose disturbance most frequently represent the most significant impact to a project site and the soils resource base therein and of areas adjacent. Section 3.3 details the determination of worst-case soils losses anticipated upon implementation of the proposed action and/or alternatives.

The success of reclamation planning relies significantly upon available resources of soil and water. Of importance to an industrial activity and environmental impact mitigation program such as that proposed at Mt. Hope is whether and in what manner management of the limited soils resource base will affect the potential for successful reclamation. Section 3.4 details an assessment of the proposed soils handling and disturbance relative to the existing soils resource capabilities. Adverse and/or significant impacts are derived therefrom.

3.2 Assumptions and Analysis Guidelines

The determination of environmental impacts upon the soils resources base required that certain assumptions be made which would affect conclusions regarding significance of impact and nature of impact (beneficial/detrimental). The general assumptions used in the analyses are presented below.

1. It was assumed that the proposed action and alternatives described briefly in Chapter 1.0 of this Technical Report and in detail in Chapter 2.0 of the EIS and Technical Report No.1 would be implemented as described. Mitigation measures described in the EIS would be in place at time designated and as described. Assumptions 2 through 10 below highlight particularly important aspects of the proposed action and alternatives described, as related to soils resources.
2. The proposed action would result in the disturbance of the soils resources in the following acreages of land:

	<u>Temporary</u>
Mine Pit	700
Non-Mineralized Material Storage Areas(2)	2,400 acres
Tailings Pond 4-A	3,460 acres
Evaporation Pond	165 acres
Plant Site and Auxiliaries	100 acres
Site Access Road	30 acres
Power Line 2-A (3.5 acres/mile)	77 acres
Water Line	132 acres
State Route Relocation	67 acres

Approximately 200 acres of soils resource base would be impacted by the proposed development of an employee subdivision. The impacts associated with the subdivision development relative to soils resource effects were not evaluated because of the uncertainty of eventual subdivision siting location.

The alternatives (excepting the no action alternative) would, upon implementation, result in the alternate disturbance of the soils resources in the following acreages of land.

Power Line 2-B	73.5 acres
Power Line 2-C	80.5 acres
Power Line 3-B	108 acres
Power Line 3-C	96 acres

Power Line 3-C	96 acres
Tailings Pond 4-B	5,650 acres
Tailings Pond 4-C	2,173 acres

3. Of the areas undergoing initial project activity disturbance, contemporaneous reclamation would occur only along rights-of-way corridors and within the areas of the process plant site between corridors. Remaining areas would not be reclaimed until cessation of ore removal operations. Upon cessation of mining, the mine pit and non-mineralized material storage areas would not be reclaimed, all other areas would be reclaimed.

Of the areas undergoing contemporaneous reclamation, soils would be redistributed to effect the following operational acreage disturbances (or permanent if roads, power line and water line are left intact for other use).

<u>Proposed Action</u>	<u>Initial Acres</u>	<u>Contemporaneous Acres</u>
Power Line 2-A	77	40
Power Line 3-A	132	42
<u>Alternatives</u>		
Power Line 2-B	73.5	38
Power Line 2-C	80.5	41
Water Line 3-B	108	34
Water Line 3-C	96	25

4. Reclamation after construction (rights-of-way corridors and inter-plant acres) would consist of stockpiled topsoil redistribution, regrading and revegetation of a ground cover as soon as possible after the construction activity was completed. Construction periods would be 11 weeks for power line; 12 to 16.5 weeks for water line; and up to two years for process plant components.
5. Topsoil and overburden would be removed and stockpiled from primarily the tailings pond site area and non-mineralized material storage areas. If

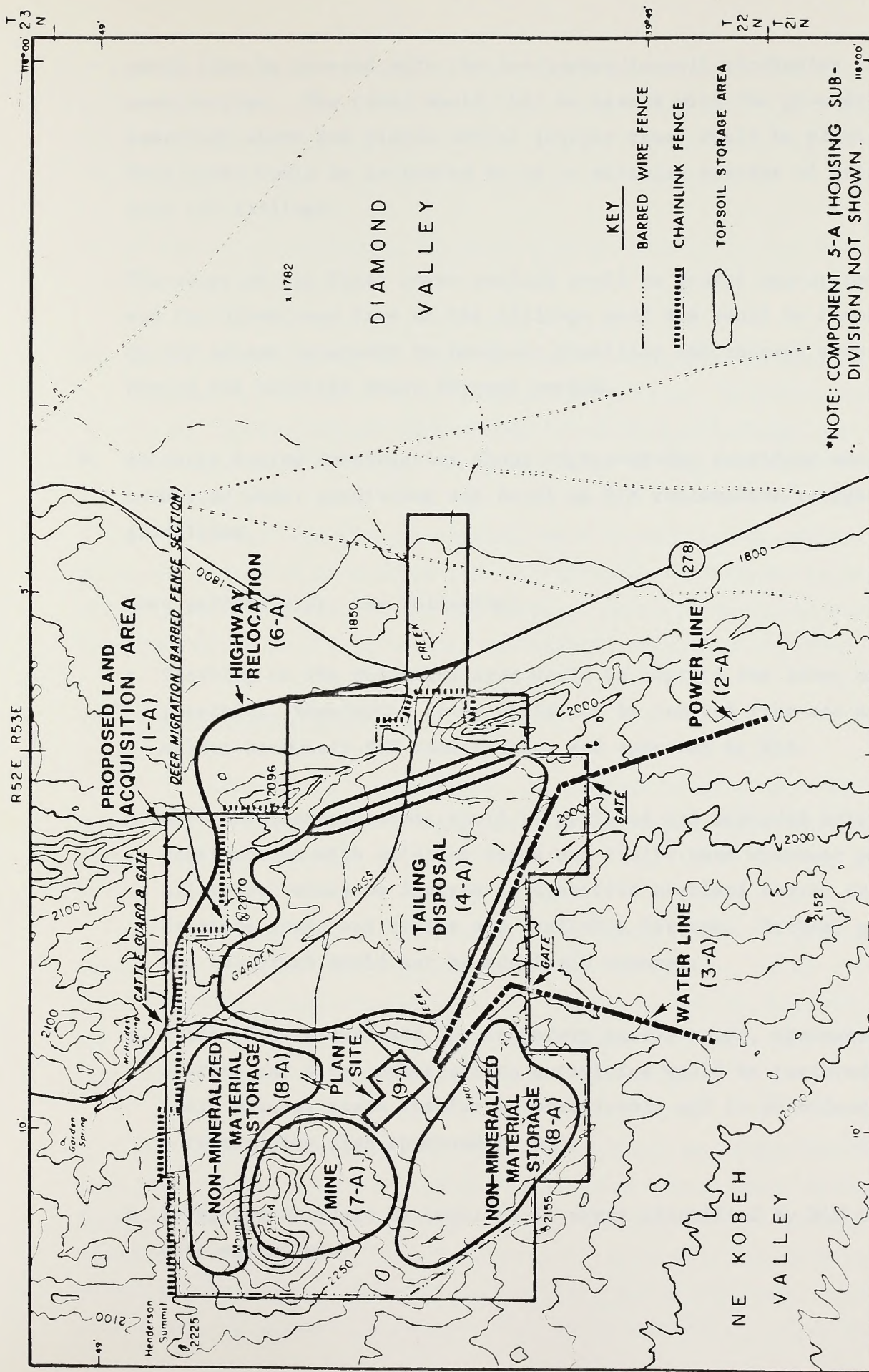
the topsoil stockpiles (Figure 3-1) are to exist for more than one year, they would be seeded for stabilization.

6. Surface runoff from the site, including that from non-mineralized material and ore storage areas, would be collected and routed to the tailings pond. As appropriate, stone rip rap and diversion ditches would be constructed to control runoff and erosion. If necessary, small catchment basins would be included in the soil erosion control plan. A larger basin would be constructed at the foot of the tailings dam to intercept and collect runoff from the dam face. The collected water would be intermittently pumped to the tailings pond.
7. Routine site erosion inspections would be conducted throughout the years of operation. Detected erosion problems would be corrected in a timely manner as a standard operating procedure. In this respect, particular attention would be given to the tailings dam.
8. Final reclamation would primarily entail, in part the following, as determined by regulations existing to date.

Mine/Non-Mineralized Material Storage Areas. The open pit mine would remain as it would exist at the end of mining. Because of the non-mineralized material storage areas would be composed of large rocks, they would not be recontoured or reclaimed.

Process Plant. The process plant and other capital facilities would be salvaged as much as possible. Unsalvagable portions would be demolished and disposed of either offsite or in the landfill. The surface would be cleaned up, graded as necessary, and revegetated. The BLM recommended cover (USDI, 1982) is a mixture of crested wheatgrass, pubescent/intermediate wheatgrass and furrowing saltbrush applied at the rate of six, three and one lbs/acre, respectively.

Tailings Pond. After the tailings pond surface has dried out, approximately two feet of rock from the non-mineralized material storage areas would be placed over the tailings. As much as possible, this rock layer



LEGEND

- EPHEMERAL STREAM
- x 2155 SPOT ELEVATION
- 50 METER CONTOUR
- 250 METER CONTOUR
- STATE ROUTE
- PROPOSED PROJECT AREA BOUNDARY

CONTOUR INTERVAL 50 METERS (164 FT)

0 1/2 1 2 MILES

0 1/2 1 2 3 KM

MAP AREA

BASE: USGS TOPO QUADRANGLES, GARDEN VALLEY & WHISTLER MTN., NEVADA

KEY

- BARBED WIRE FENCE
- CHAINLINK FENCE
- TOPSOIL STORAGE AREA

***NOTE: COMPONENT 5-A (HOUSING SUB-DIVISION) NOT SHOWN.**

MT. HOPE MOLYBDENUM PROJECT

FENCE AND TOPSOIL STORAGE PLANS

U.S. Department of the Interior
Bureau of Land Management

FIGURE 3-1

would then be covered with the overburden/topsoil stockpiled during construction. The cover would then be seeded with the groundcover specified above and pinyon and/or juniper trees would be planted. This cover would be contoured so as to minimize seepage of precipitation into the tailings.

The slope of the final cover surface would be graded appropriately and the downstream face of the tailings pond dam would be recontoured to the extent necessary to maintain stability and control erosion during the tailings basin dry-out period.

9. Activity during construction along rights-of-way corridors would be conducted under conditions set forth as BLM reclamation/revegetation guidelines.

Most particularly, the following:

- Clearing of the disturbed area would be kept to the least amount possible. Vegetation cover would not be removed from any area unless necessary for construction and approved by BLM.
- All construction access would be reviewed and approved prior to construction with existing roads and trails used wherever possible. All travel would be limited to specified overland routes unless existing roads and trails are available for use. Natural grass and low brush would not be routinely removed.
- Public land areas used for temporary access roads, equipment storage and other construction activities would be restored to their natural state insofar as practicable and in accordance with a restoration plan approved by BLM.
- Revegetation would be required in areas identified by BLM on the date specified.

- Reasonable means would be used to minimize erosion and soil damage in connection with any construction, rehabilitation or maintenance operations, including, but not limited to, construction of water bars, cross ditches or other structures, if necessary.
 - Any ruts, depressions or other such disturbance caused by construction would be restored.
10. Direct contamination of soils by process components or mine operations would occur but would be of limited extent (e.g., machinery oil on topsoil, etc.). It was assumed that standard operating procedures would include protective measures (e.g., stockpile sign marking, restricted traffic).

Several specific assumptions used in calculating changes in erosion rates are discussed in Section 3.3. Significance of impacts to soil resources was defined in relation to the magnitude of change expected in soil resource base quantities and potential for reclamation/revegetation capabilities.

3.3 Soil Erosional Losses

Soil erosion losses, water and aeolian (wind), were calculated to assess soil resource impacts associated with implementation of the proposed action and alternatives.

Soil losses and disturbance would occur primarily during construction phases (disturbance along rights-of-way, in the vicinity of facility structures and at collection and storage areas of topsoil at the Mt. Hope site) and at the earliest stages of final reclamation between the time that stockpiled topsoil was spread and vegetation was re-established.

A potential impact of significance involves severe erosional loss of a soils resource base following the inherent displacement mixing, and exposure that occurs during soils salvage and handling for reclamation purposes. Upwards of 9,000,000 cubic yards of topsoil may be designated for use to assure reclamation potential (see Section 3.4 discussion). Contemporaneous reclamation throughout the project life would primarily involve the tailings

dam face as reclamation at the rights-of-way corridors would be expected to occur within the year of construction. Soil erosional losses at the dam face could be significant if not controlled or anticipated due to the areal extent of the dam and the natural erosional force presented by its height and angle of slope. The following sections present the analytical evaluations of wind and water erosion potential for each of the tailings dams studied (proposed action 4-A; alternates 4-B and 4-C). Section 3.3.4 presents erosion potential discussion for the operational components less significant in soils erosional potential.

3.3.1 Determination of Soils Affected

The soils mapping conducted for baseline descriptive purposes was reviewed relative to proposed action and alternative components placement to identify the soils types to be affected by project implementation. Tables 3-1 through 3-4 list soils types affected by individual component actions. In the case of soils within the proposed project area boundary and tailings pond site alternatives, soil acreages have been calculated by planimetry and listed. Soil acreages were not calculated along rights-of-way alignments due to the preferred corridor approach of land use specification. For example, the proposed water line would entail the permanent disturbance of approximately 42 acres. However, within the corridor areas several thousand acres exist which will not be affected by eventual alignment. For impact analysis purposes (Section 3.3.4), certain assumptions were made that allowed averaging effects in the determination of quantitative results.

3.3.2 Water Erosion Impacts

Soil losses along the dam face analyzed by period:

- Exposed-mixed soils immediately following soil redistribution.
- Mulched-redistributed soil with two tons per acre mulch applied.
- Revegetation at approximately half baseline conditions.

Mt. Hope Molybdenum Project

Table 3-1 Soils Within the Proposed Project Area Boundary Mt. Hope, Nevada

Mapping Unit	Soil Name	Acreage	Percent of Total Acreage
RAC	Ratto gravelly fine sandy loam, 2-8% slopes	3,133.27	31.36
LK	Labshaft - Rock outcrop complex	2,341.68	23.43
LAF	Labshaft - Locane association, very steep	1,374.54	13.76
321	Mau-Shagnasty - Eightmile association	867.78	8.68
AT	Atrypa association	622.68	6.23
Kba	Kobeh sandy loam, 0-2% slopes	390.83	3.91
SMA	Shipley silt loam, occasionally flooded, 0-2% slopes	351.09	3.51
764	Shagnasty-Roca-Rock association	284.84	2.85
681	Chad-Cleavage - Softscrabble association	178.86	1.80
HS	Hopeka-Sheege association	129.18	1.29
HDD	Handy gravelly loam, 4-15% slopes	96.05	0.96
IAE	Labshaft-Locane association, steep	86.12	0.86
Ln b	Lone gravelly loam, undulating	66.24	0.66
RHC	Rubyhill fine sandy loam, 2-8% slopes	26.50	0.27
831	Atrypa-Mau association	23.19	0.23
HE	Hayeston-Silverado association	19.88	0.20
TOTAL		9,992.73	100.00

Mt. Hope Molybdenum Project

Table 3-2 Soil Associations Along the Proposed and Alternative Power Line Routing Corridors

Proposed Routing 2-A

Fera-Roca-Devoy association (9)
Ratto-Handy-Pedoli association (8)
Labshaft-Hopeka association (10)
Nayped-Shipley association (1)
Silverado-Hayeston-Credo association (7)
Kobeh-Alhambra association (3)
Umil-Bobs association (5)

Alternative Route 2-B

Fera-Roca-Devoy association (9)
Ratto-Handy-Pedoli association (8)
Labshaft-Hopeka association (10)
Nayped-Shipley association (1)
Playas-Dianev association (2)
Silverado-Hayeston-Credo association (7)
Kobeh-Alhambra association (3)
Umil-Bobs association (5)

Alternative Route 2-C

Fera-Roca-Devoy association (9)
Ratto-Handy-Pedoli association (8)
Umil-Bobs association (5)
Labshaft-Hopeka association (10)
Rubyhill association (4)
Silverado-Hayeston-Credo association (7)
Nayped-Shipley association (1)
Playas-Dianev association (2)
Kobeh-Alhambra association (3)

Mt. Hope Molybdenum Project

Table 3-3 Soil Associations Along the Access Road, Highway Relocation and Water Line Corridors

ACCESS ROAD	HIGHWAY RELOCATION
Ratto-Handy-Pedoli association (8)	Umil-Bobs association (5)
Umil-Bobs association (5)	Labshaft-Hopeka association (10)
	Rubyhill association (4)

PROPOSED WATER LINE CORRIDOR 3-A
AND ALTERNATIVE CORRIDOR 3-B

Fera-Roca-Devoy association (9)
Labshaft-Hopeka association (10)
Ratto-Handy-Pedoli association (8)
Rubyhill association (4)
Kobeh-Alhambra association (3)

ALTERNATIVE WATER LINE CORRIDOR 3-C

Fera-Roca-Devoy association (9)
Labshaft-Hopeka association (10)
Umil-Bobs association (5)

Mt. Hope Molybdenum Project

Table 3-4 Soil Associations within the Proposed Alternative Tailings Pond Sites

PROPOSED SITE		ACREAGE	PERCENT OF TOTAL ACREAGE
A	Ratto-Handy-Pedoli association (8)	2,328.05	67.33
(component 4-A)	Labshaft-Hopeka association (10)	958.60	27.72
	Umil-Bobs association (5)	<u>171.18</u>	<u>4.95</u>
	TOTAL	3,457.83	100.00
<u>ALTERNATIVE SITES</u>			
I	Kobeh-Alhambra association (3)	5,528.77	97.87
(component 4-B)	Playas-Dianev association (2)	<u>121.07</u>	<u>2.14</u>
	TOTAL	5,648.84	100.01
J	Labshaft-Hopeka association (10)	999.58	46.0
(component 4-C)	Umil-Bobs association (5)	651.90	30.0
	Rubyhill association (4)	<u>521.52</u>	<u>24.0</u>
	TOTAL	2,173.00	100.0

- revegetation at approximately baseline conditions.

Soil losses within the mine/non-mineralized material storage areas were evaluated as insignificant due to the exposed, rock surface characteristics and the fact that these areas would not be subject to soil replacement during reclamation. By evaluating probable erosional losses prior to, during and after establishment of vegetation and topography, actual reclamation potential of the soils can be estimated.

Potential soil losses due to water erosion along the tailings pond dam face were estimated based on a weighted average of each soil type disturbed within the pond area. The Universal Soil Loss equation (U.S.D.A., Soil Conservation Service, 1976) developed by the SCS was used for calculation purposes. This equation is an empirically derived relationship, the application of which involves making certain assumptions and allows only estimates of approximate erosional losses. It does take into consideration several soil, climate and topographic factors including soil erodibility potential, length and steepness of slope, vegetative or other cover, rainfall, and (where applicable) cropping practices.

The assumptions used concerned both the present and future conditions. Assumptions used that are specific to either the water erosion or the wind erosion equation (Section 3.3.3) are explained in the following (and Section 3.3.3). General assumptions used in both equations were as follows:

- Soils would be stripped to a depth of 12 inches

The characteristics of the reapplied soil material would be the same as those of the stripped soils, based on weighted average by acreage disturbed.

- Exposure period would equal one full year climatic cycle.
- Dam face would be 3:1 slope with 165 foot intervals between terraces.

Water Erosion - Assumptions and Parameters of Calculation

Table 3-5 lists the specific values utilized to compute the Universal Soil Loss equation. The following briefly described those values.

This soil loss equation is expressed as:

$$A = R K L S C P$$

where: A = the computed average annual soil loss in tons per acre;
R = the rainfall factor expressed in the number of erosion units in a year's rain, which are a measure of the erosive force of rainfall;
K = the soil erodibility factor, which is the erosion rate per unit of erosion index for a specific soil in a continuous cultivated fallow on a 9 percent slope 72.6 feet long;
L = the slope length factor, which is the ratio of soil loss from the slope length of the field to that from a 72.6 foot length on the same soil type and slope;
S = the slope gradient factor, or the ratio of soil loss from the field gradient to that from a 9 percent slope;
C = the cropping management factor defined as the ratio of soil loss from a field with specified cropping and management to that from bare fallow condition on which the K factor was evaluated;
P = the erosion control practice factor, or the ratio of soil loss with contouring, strip cropping, or terracing to that with straight row farming directly up and down the slope.

- R value was 24 at sites 4-A and 4-C and 19 at site 4-B per SCS (Reno) 1/83 maps.
- K values were based on a weighted average of the disturbed soils. A weighted average by depth (to 12 inches) was calculated for each soil

Mt. Hope Molybdenum Project

Table 3-5 Specific Values Used in Water Erosion Calculations

Condition	Alternative		
	Mine Site 4-A	Diamond Valley 4-B	Kobeh Valley 4-C
Baseline	R - 24	R - 19	R - 24
	K - .177	K - .216	K - .20
	LS - 7.3	LS - .21	LS - 2.17
	C - .13	C - .12	C - .12
	P - 1	P - 1	P - 1
Exposed	R - 24	R - 19	R - 24
	K - .177	K - .216	K - .20
	LS - 11.7	LS - 11.7	LS - 11.7
	C - 1	C - 1	C - 1
	P - 1	P - 1	P - 1
Mulched	R - 24	R - 19	R - 19
	K - .177	K - .216	K - .216
	LS - 11.7	LS - 11.7	LS - 11.7
	C - .17	C - .17	C - .17
	P - 1	P - 1	P - 1
Reveg-1	R - 24	R - 19	R - 19
	K - .177	K - .216	K - .216
	LS - 11.7	LS - 11.7	LS - 11.7
	C - .20	C - .20	C - .20
	P - 1	P - 1	P - 1
Reveg-2	R - 24	R - 19	R - 19
	K - .177	K - .216	K - .216
	LS - 11.7	LS - 11.7	LS - 11.7
	C - .10	C - .10	C - .10
	P - 1	P - 1	P - 1

sufficiently low soil losses so as not to adversely effect the potential for revegetation success.

As Table 3-6 indicates, soil loss potential due to water erosion of site 4-B were estimated to be very low at baseline conditions (0.10 tons/acre/year) while maximum erosion would occur immediately following soil replacement and prior to vegetation establishment or mulching (48 tons/acre/year). Water erosion at site 4-B would result in slightly less soil loss per acre than that predicted at the proposed action site 4-A. This difference is due primarily to the lower amounts of precipitation received in the valley location of site 4-B. Site 4-C would erode approximately 10 percent more than site 4-A, primarily due to the more erosive nature of the soils disturbed at site 4-C.

3.3.3 Wind (Aeolian) Losses

Potential annual wind erosion losses were calculated on a per acre basis for mixed soils to be disturbed during the tailings pond construction. These calculations were based on the wind erosion equation developed by Woodruff and Siddoway (1965) and allow a review of soil losses from flat or slightly sloping surfaces such as the tailings pond.

Wind Erosion - Assumptions and Parameters of Calculation

The equation is $\text{Soil Loss} = I'K'C'L'V$, where:

I' = soil erodibility

K' = soil roughness factor

C' = climatic factor

V = vegetation cover variable and

L' = complex function of field width

- Soil erodibility (I) values were determined using a weighted average of the disturbed soils. A weighted average by depth (to 12 inches) was calculated for each soil series disturbed. An overall weighted average by acreage of each series disturbed was then calculated.

Mt. Hope Molybdenum EIS

Table 3-6 Estimated Water Erosion Losses at the Tailings Pond Dam Face
(in tons/acre/year)

Site	Tailings Pond 4-A	Tailings Pond 4-B	Tailings Pond 4-C
Baseline (undisturbed soils)	4.1	0.10	1.25
Exposed	49.7	48	56.2
Mulched	8.4	8.2	9.5
Reveg-1	9.9	9.6	11.2
Reveg-2	5.0	4.8	5.6

Source Equation: USDA Agriculture Handbook No. 537; Soil Conservation Service (Reno). Equation factors:

- Baseline cover estimates for pinyon-juniper vegetation type are 25% canopy cover and 30% ground cover; for big sagebrush vegetation types, 50% canopy cover and 30% ground cover; and for the winterfat-sagebrush type, 50% canopy cover 30% ground cover.
- Revegetation cover estimates were 0% canopy and 20% ground cover for reveg-1 and 0% canopy and 40% ground cover to reveg-2.
- Dam face slope was assumed to be 3:1 in accordance with Chapter 2. Slope lengths were assumed to be 165 feet between terraces.
- Exposure was assumed to include a full year climatic cycle.
- Rainfall factor was assigned a value of 24 at sites 4-A and 4-C and 19 at site 4-B as per SCS (Reno) R factor maps (1/83).

- K value was assumed to be 1, equivalent to a smooth bare soil.
- C value was .40 (40 for Eureka, Nevada), per SCS (Reno) 4/75 map.
- V values were as follows:

Baseline	-	1000
Bare	-	0
Mulched	-	4000
Reveg-1	-	500
Reveg-2	-	1000

- L values were assumed to be 110 feet for baseline conditions and 10,000 feet for tailings pond surface.

Table 3-7 lists the specific values used for computational purposes at each tailings pond site.

Wind (Aeolian) Loss - Results

Results indicate that final reclamation will result in an aeolian loss calculated at 2.6 tons/acre/year at the proposed tailings pond Alternate 4-A (Table 3-8). Based on a standard of 5.0 tons/acre/year value, the anticipated impact of soil loss would be considered insignificant.

Wind erosion rates calculated for alternative site 4-C were intermediate to sites 4-A and 4-B. The wind erosion rates applicable to all periods at site 4-C were at least double the soil loss quantities estimated for site 4-A and 50 percent more than at site 4-B. This difference is largely due to soil texture variables.

Mt. Hope Molybdenum Project

Table 3-7 Specific Values Used in Wind Erosion Calculations

Condition	Alternative		
	Mine Site 4-A	Diamond Valley 4-B	Kobeh Valley 4-C
Baseline	I - 38	I - 86	I - 56
	K - 1	K - 1	K - 1
	C - 40	C - 40	C - 40
	V - 1000	V - 1000	V - 1000
	L - 100	L - 100	L - 100
Exposed	I - 38	I - 86	I - 56
	K - 1	K - 1	K - 1
	C - 40	C - 40	C - 40
	V - 0	V - 0	V - 0
	L - 10,000	L - 10,000	L - 10,000
Mulched	I - 38	I - 86	I - 56
	K - 1	K - 1	K - 1
	C - 40	C - 40	C - 40
	V - 4000	V - 0	V - 0
	L - 10,000	L - 10,000	L - 10,000
Reveg-1	I - 38	I - 86	I - 56
	K - 1	K - 1	K - 1
	C - 40	C - 40	C - 40
	V - 500	V - 500	V - 500
	L - 10,000	L - 10,000	L - 10,000
Reveg-2	I - 38	I - 86	I - 56
	K - 1	K - 1	K - 1
	C - 40	C - 40	C - 40
	V - 1000	V - 1000	V - 1000
	L - 10,000	L - 10,000	L - 10,000

Mt. Hope Molybdenum EIS

Table 3-8 Estimated Wind Erosion Losses on Surface of Tailings Pond
(per acre)

Conditions	Tailings Pond 4-A	Tailings Pond 4-B	Tailings Pond 4-C
Baseline	<0.4	1.6	<0.5
Exposed	15.2	36.4	22.4
Mulched	<0.9	<0.5	<0.6
Reveg-1 (half)	8.7	21.7	13.4
Reveg-2 (baseline values)	2.6	8.2	4.5

Source Equation: Woodruff, N. P. and F. H. Siddoway, 1965. A Wind Erosion Equation. Soil Sci. Soc. Amer. Proc. 29:602-608

3.3.4 Corridor Right-of-Way Impacts

As discussed in Section 3.3.1, several thousand acres have been identified in a corridor alignment scenario for eventual water line and power line routing. The corridor establishment (versus pre-establish set linear routing of the exact right-of-way width) allows the potential for in-the-field mitigation via rerouting avoidance. The corridor method of route establishment is the preferred alternative of BLM as it does effectively increase mitigation potential. As such, however, it precludes detailed soils erosion analyses as the calculations required necessitate specific site information including the topographic factor LS (highly dependent on the uniformity of the slope gradient of the soil plot) and the crop management factor C which takes into consideration vegetative cover type and percent exposure.

Thus, analysis of soils resource base impacts along the corridor rights-of-way were determined to be generally limited to worst-case scenarios with the inclusion of the anticipated mitigation measures introduced by BLM right-of-way approvals (e.g. contemporaneous reclamation, rill and gully control, etc. see Section 3.2).

Soils directly impacted by power line, water line and highway relocation would obviously be exposed to direct (displacement, loss of settled compaction) and indirect (climatic element) erosional forces. Taken as a whole, approximately 276 acres of soils resource base would initially be disturbed by implementation of the proposed action (power line: 77 acres, water line: 132 acres, highway relocation: 67 acres). Reclamation following construction would result in a reduced acreage effect totalling 149 acres (power line: 40 acres, water line: 42 acres, highway relocation: 67 acres). Under worst-case scenarios, the soils resources underlying the highway relocation component would be permanently lost from the resource base. Soils along the power line and water line access roads and facility structures would be impacted directly but not in a long-term manner. Soils removed during construction would be dispersed laterally (parallel to routing) at which point erosional forces would tend to dissipate some of the resource base to the immediately adjacent areas. The, narrow, linear nature of the

affected areas effectively precludes significant impacts to the soils resource bases as an area entity. Indeed vegetation encroachment following construction reclamation would present operational maintenance requirements of control, particularly in the case of brush fire prevention along the power line route. Wind erosion would be significantly low due to the generally limited exposure area and surrounding vegetation which would be undisturbed.

While rill and gully development will occur, particularly in areas of steep slope and as a result of the frequency of thunderstorm precipitation. It has been assumed, however, that the rights-of-way management stipulations set forth by the BLM would preclude significant erosional problems which would eventually lead to a broader influence area of impact if not implemented. In total, it is not anticipated that erosional impacts would be significantly different than that existing at present.

Implementation of the alternatives would result in impacts differing only in the actual specific soils affected and acreage variations of small quantity (e.g. power lines 2-B and 2-C: 38 and 41 acres, respectively, versus the proposed route 2-A of 40 acres; water lines 3-B and 3-C: 34 and 25 acres, respectively, versus the proposed route 3-A of 42 acres).

3.4 Impacts to Soils Resource Capabilities

Selective topsoil salvage prior to mining and subsequent replacement are vital to the successful reclamation of most mining operations. Schuman and Power (1980) indicated that topsoiling increases infiltration, improves rooting media for plant establishment, enhances nutrient cycling, and may serve as a source of seed, rhizomes, and root cuttings which may promote species diversity in the resulting stand of vegetation.

In general, plant growth is enhanced with increased topsoil depth. Parton et al (1978) indicated that primary and secondary production increased linearly as topsoil depth increased to 60 cm (24 inches). Interestingly, responses to increased topsoil depth and incremental production increases were greater for secondary producers (cattle) than those of primary producers (plants). Power (1978) studied the effects of topsoil quality and depth on

plant growth at the Glenharold Mine, near Stanton, North Dakota. Using topsoil material of a silt loam texture, he demonstrated increases in the yields of grains, alfalfa (Medicago sativa) and perennial grasses in response to increases in topsoil depth to 60 to 75 cm (24 to 29 inches); no significant yield increases were noted where topsoil depths exceeded 75 cm (29 inches). Gould (1978) evaluated vegetation establishment with regard to variable topsoil depths at the San Juan Mine in northwestern New Mexico. Using topsoil treatments of 0, 20 and 45 cm (0, 8 and 18 inches respectively) and mixtures of topsoil and spoil material, he found that the most vigorous plants were those growing in plots receiving 20 cm or greater of topsoil (in addition to supplemental irrigation). In Wyoming, Barth and Martin (1982) constructed a topsoil "wedge" (0 to 5 feet thick) over acidic spoil materials. As soil depth increased, perennial grass yield increased in a linear manner; maximum yields occurred at topsoil depths greater than five feet. Plant roots always penetrated to the maximum depth of topsoil provided (Barth and Martin, 1982).

Of course, it should be realized that topsoil should be of suitable quality. Increased depths of poor quality rooting media will likely not improve conditions for plant growth. Schafer (1980) proposed criteria for evaluation of topsoil suitability for stripmine reclamation (refer to Table 3-9). Evaluation of Mt. Hope project area topsoils with regard to Schafer's criteria indicates that the following soils are most suitable for salvage: Ratto gravelly sandy loam, Atrypa soils, Kobeh sandy loam, and Shipley silt loam. The remaining soils are stony, although they are generally acceptable with regard to the remaining criteria. The basis for these determinations is data presented by Archer (1980).

Calculations indicate a total salvageable topsoil volume for all of the major disturbed sites (excluding pipeline, road and highway construction sites) of nearly 12 million cubic yards (Table 3-10). However, upon adjusting this figure by subtraction of stony soil volumes, the resulting salvageable topsoil volume is approximately 6 million cubic yards. Topsoil storage sites are illustrated on Figure 3-1. As delineated, the area between the plant site, tailings disposal site and southern non-mineralized material storage area would be acceptable as would the area between the plant site, mine, north non-mineralized material storage area and the tailings pond (not shown).

Mt. Hope Molybdenum Project

Table 3-9 Criteria for Rating Topsoil Suitability for Use as
Cover-soil Material in Western Stripmine Reclamation

Factor Affecting Use	Good	Fair ^{1/}	Poor ^{2/}
Texture class	vfsl,fsl,sl,l,sil	lfs,ls,cl,scl,sicl	s,c,sc,sic
Moist consistence	very friable, friable	loose firm	very firm ex. firm
EC (mmhos/cm)	<4	4-8	>8
ESP	0-5	5-15	>15
pH	5.6-7.8	4.5-5.6; 7.8-8.4	<4.5, >8.4
Stoniness class	0	1	2-5
Available water (% by volume)	>10	5-10	<5
Rock fragments (%)	<15	15-35	>35
Saturation water (%)	25-80	25-80	<25; >80

^{1/} Mitigation of adverse properties would increase reclamation potential.

^{2/} Materials rated as poor may be suitable as topsoil only if adverse factors were treated.

Mt. Hope Molybdenum Project

Table 3-10 Salvageable Topsoil Depths and Volumes

<u>Site</u>				
Non-mineralized Material Storage (North Area)				
<u>Soil Type</u>	<u>Acreage</u>	<u>Horizon (Depth ft.)</u>	<u>Volume (YD³)</u>	<u>Texture</u>
RAC	581	A (0.67)	628,022	gravelly fine sandy loam
		B (0.58)	543,661	gravelly clay
AT	1.5	A (0.58)	1,404	gravelly loam
MAE (321)	190	A (0.5)	153,267	stony loam
		B (1.8)	551,760	gravelly clay/clay loam
681	29	-----NO DATA-----		
TOTAL VOLUME (A HORIZON)			782,693	
TOTAL VOLUME (B HORIZON)			1,095,421	
<hr/>				
Non-mineralized Material Storage (South Area)				
LK	851	A (1.0)	1,372,947	very stony loam
		B (0.58)	796,309	gravelly sandy clay loam
RAC	179	A (0.67)	193,487	gravelly fine sandy loam
		B (0.58)	167,496	gravelly clay
764	42	A (0.34)	23,038	very stony loam
		B (1.67)	113,159	gravelly clay loam/gravelly clay
TOTAL VOLUME (A HORIZON)			1,589,472	
TOTAL VOLUME (B HORIZON)			1,076,964	

Mt. Hope Molybdenum Project

Table 3-10 Salvageable Topsoil Depths and Volumes (continued)

<u>Mine Site</u>				
<u>Soil Type</u>	<u>Acreage</u>	<u>Horizon (Depth ft.)</u>	<u>Volume (YD³)</u>	<u>Texture</u>
RAC	101	A (1.0)	162,947	very stony loam
		B (0.58)	94,509	gravelly sandy clay loam
764	42	A (0.34)	23,028	very stony loam
		B (1.67)	113,159	gravelly clay loam/gravelly clay
MAE (321)	440	A (0.5)	354,933	stony loam
		B (1.8)	1,277,760	gravelly clay/loam
RAC	188	A (0.67)	127,550	gravelly fine sandy loam
		B (0.58)	110,416	gravaelly clay
TOTAL VOLUME (A HORIZON)			7,668,468	
TOTAL VOLUME (B HORIZON)			1,595,844	
<hr/>				
<u>Plant Site</u>				
RAC	103	A (0.67)	111,336	gravelly fine sandy loam
		B (0.58)	96,380	gravelly clay
TOTAL VOLUME (A HORIZON)			111,336	
TOTAL VOLUME (B HORIZON)			96,380	

Mt. Hope Molybdenum Project

Table 3-10 Salvageable Topsoil Depths and Volumes (continued)

<u>Tailings Disposal</u>				
<u>Soil Type</u>	<u>Acreage</u>	<u>Horizon (Depth ft.)</u>	<u>Volume (YD³)</u>	<u>Texture</u>
AT	197	A (0.58)	184,339	gravelly loam
RAC	1208	A (0.67)	1,305,767	gravelly loam sandy loam
Kba	216	A (0.58)	202,118	sandy loam
		B (0.83)	289,238	gravelly fine sandy loam
LAF	490	A (1.0)	790,533	very stony/ extremely sandy loam
		B (0.58)	458,509	gravelly clay loam
SMA	7	A (0.25)	2,823	silty loam
LK	235	A (1.0)	379,133	very stony loam
		B (0.58)	219,897	gravelly sandy clay loam
TOTAL VOLUME (A HORIZON)			2,864,713	
TOTAL VOLUME (B HORIZON)			2,098,010	
<hr/>				
<u>ALL SITES</u>				
TOTAL SALVAGEABLE A HORIZON MATERIAL			6,016,682 cubic yards	
TOTAL SALVAGEABLE B HORIZON MATERIAL			5,962,619 cubic yards	

Soil acronyms and their appropriate delineations.

AT Atrypa association.
 Kba Kobeh sandy loam.
 LK Labshaft - Rock outcrop complex.
 LAF Labshaft - Locane association, very steep.
 MAE (321) Mau series.
 RA1 Ratto gravelly fine sandy loam, 0-2% slopes.
 SHA Shipley silt loam, occasionally flooded, 0-2% slopes.
 764 Used data from Roca series.

Both sites would provide for a relatively short haul to the major areas to be revegetated, these being the plant site and tailings disposal site. Assuming a stockpile depth of 6 feet, topsoil storage would require approximately 573 acres. The acreage required would vary with the topsoil storage depth. The 6-foot storage depth is favored as this would provide for a substantial amount of "living" soil available for redistribution at the time of reclamation. It should be noted that stockpiling generally reduces the overall viability of topsoil with regard to its biotic components (soil microbes, deeply buried seed etc.). Although the deeper soil layers (perhaps beyond 3-4 feet) may lose some of their value as topsoil, the upper layers which would be vegetated during the 50 year mining period would continue to function as "living topsoil." Therefore, at the time of reapplication, this topsoil would essentially be hauled directly to the sites to be reclaimed. Direct haul has been demonstrated as being a superior method of topsoil handling as it provides a volunteer seed source (King, 1980) and when compared to stockpiled (in this case deeply stockpiled) topsoil, it contains more organic matter, has lower bulk density and is more favorable in terms of nutrient availability and microbial functioning (Coenenberg, 1982).

Schuman and Power (1980) indicated that the amount of topsoil required for mined land reclamation is site specific. Also, topsoil availability is usually the most limiting factor. At Mt. Hope, salvage of all of the non-stony soils from the disturbed sites would yield enough topsoil to cover the tailings area and plant site with approximately 16.8 inches (43 cm) of topsoil. Thus, after redistribution, more topsoil would be available for plant growth than currently exists at these sites (refer to Table 3-10).

The potential for reclamation at Mt. Hope is believed to be good considering current advances in reclamation technology and resources which are available to EXXON. Adequate supplies of topsoil are available as are plant species which are adapted to local conditions. Coupled with the use of supplemental irrigation, establishment of a suitable permanent stand of vegetation should not be overly difficult provided that the seedings are adequately protected during the establishment phase (see Technical Report No.6, Biota, for a detailed review of reclamation potential).

CHAPTER 4.0
LIST OF REVIEWERS AND PREPARERS

4.1 Reviewers - Bureau of Land Management

TERESA McPARLAND, Area Geologist

B.A. Geology, Stephens College, MO.

Experience includes four years experience with Bureau of Land Management; coordinator, writer-editor; geology review.

CALVIN McKINLAY, District Soil Scientist

B.S. Agronomy, Utah State University, Logan

Experience includes five years with Bureau of Land Management; erosion review.

4.2 Consultants

ROBERT C. WYATT, Project Manager

B.S. in Biology, University of Miami

Post Graduate Study, Biology, University of Miami

Mt. Hope Project: Responsible for coordination of environmental discipline impact analyses (except cultural resources) and direction of the third party EIS scientific team; technical and regulatory (NEPA) oversight and management of EIS documentation; and liaison and coordination with the Bureau of Land Management (BLM) and EXXON.

Experience includes management and technical analyses of environmental impact studies involving surface and underground mines, nuclear and coal-fire electrical generating plant, petrochemical and mineral process facilities, and hazardous waste/nuclear disposal site regulatory

analysis. Professional experience involving activity in 23 states, Mexico and Puerto Rico has included the technical critique and environmental discipline analysis of hydrology, air quality, chemical and mine engineering, terrestrial and aquatic biology, socioeconomics, land use, pollutant toxicity and regulatory compliance.

JOHN J. KNEISS, Environmental Analyst

B.S. in Biology, Wilkes College

Mt. Hope Project: Responsible for assisting baseline data acquisition programs, review of process plant environmental loadings and analysis of soils loss characteristics.

Professional experience includes environmental analysis in the technical disciplines of soil science, wildlife ecology, vegetation and hazardous wastes disposal. Site development and impact assessment work has entailed underground mining, deep well injection, chemical process lagoon and sewage treatment facilities planning.

RANDALL K. BUSH, Geologist/Data Analyst

B.S. in Geology, University of Houston

Mt. Hope Project: Assisted in the preparation and data abstraction required for EIS technical reporting. Coordinated EIS documentation relevant to mapping and quality assurance.

Professional experience includes technical writing and regulatory compliance documentation for numerous coal and mineral mines; technical critique of topographic and geologic data and support documentation; and land use analysis (physical environmental factors relevant to engineering planning).

RICHARD TRENHOLME, Soil Scientist

B.S. in Agronomy, Texas A & M University

Post Graduate Studies - soils, Texas A & M University

Mt. Hope Project: Responsible for review and analysis of project impacts upon soils resources. Conducted analytical determinations of soil, wind and water losses. Assisted in the preparation and review of technical reports and soils mapping.

Experience includes: mapping, classification, and impact analysis of soils for surface and underground mining projects; conducting soil fertility studies; design, implementation and assessment of reclamation activities pursuant to federal and state regulations. Professional experience includes Soil Conservation Service and U.S. Forest Service employment in the western United States.

CHAPTER 5.0
SOIL GLOSSARY

Acid soil. A soil with a preponderance of hydrogen and aluminum ions in proportion to hydrozyl ions. Specifically, soil with a pH value <7.0.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as crumbs, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkaline soil. A soil with a high degree of alkalinity or with a high exchangeable sodium content, or both. Specifically, any soil that has a pH value >7.0.

Alluvial apron. The area of intermediate slope at the base of mountain ranges and composed of coalescing alluvial fans.

Alluvial fan. A fan-shaped deposit of sand, gravel and fine material dropped by a stream where its gradient lessens abruptly. Usually found at the base of highland terrain in arid regions.

Alluvium. A general term for all detrital material deposited or in transit by streams, including gravel, sand, silt, clay and all variations and mixtures of these.

Aquifer. A formation, group of formations, or part of a formation that is water bearing.

Available water capacity. (also termed available moisture capacity).

The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount of wilting point. It is commonly expressed as inches of water per inch of soil and by the soil profile as follows:

Very low	less than 2.5 inches
Low	2.5 to 5 inches
Moderate	5 to 7.5 inches
High	more than 7.5 inches

Base saturation. The degree to which material that has base-exchange properties is saturated with exchangeable cations other than hydrogen, expressed as a percentage of the cation-exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bunch grass. A grass that grows in tufts, in contrast to a sod-forming grass.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Clay. As a soil separate, the mineral solid particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 45 percent silt.

Clay film. A thin coating of clay on the surface of a soil aggregate.
Synonyms: clay coat, clay skin.

Coarse fragments. Mineral or rock particles more than 2 millimeters in diameter.

Coarse-textured soil. Sand and loamy sand.

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are -

Loose. - Noncoherent when dry or moist; does not hold together in a mass.

Friable. - When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm. - When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic. - When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky. - When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard. - When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft. - When dry, breaks into powder or individual grains under very slight pressure.

Cemented. - Hard and brittle; little affected by moistening.

Depth, Soil. Depth of soil profile; depth to which the roots of common plants penetrate; depth to underlying bedrock, duripan or other resistant layer. Soil depth classes are: very shallow, less than 20 inches; shallow, 10 to 20 inches; moderately deep, 20 to 40 inches; deep, 40 to 60 inches; and very deep, over 60 inches.

Durinode. Weakly silica cemented to indurated nodules which do not slack down in water or strong acid but are soluble in hot concentrated alkali or with alternate treatment with hot concentrated alkali and acid.

Duripan. A silica cemented subsurface layer in which the cementation is strong enough not to clack in water or strong acid but is soluble in hot concentrated alkali and acid.

Erosion. The wearing away of the land surface by wind (sandblast), running water, and other geological agents.

Erosion pavement. A layer of gravel or stones on the ground surface that remains after the fine particles are removed by wind or water. Desert pavements result from exposure to dry winds.

Fine-textured soils. Moderately fine textured: Clay loam, sandy clay loam, silty clay loam; Fine-textured: sandy clay, silty clay, and clay. Roughly, soil that contains 35 percent or more of clay.

Flood plain. Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material may be sandy or clayey, and it may be cemented by iron oxide, silica, calcium carbonate, or other substance.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon. - The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon. - The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon. - The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon. - The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer. - Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Igneous rock. Rock that has been formed by the cooling of molten mineral material. Examples: Granite, syenite, diorite, and gabbro.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. It may be limited either by the infiltration capacity of the soil or by the rate at which water is applied to the surface soil.

Lacustrine. Produced by or belonging to a lake environment. (Emmons, Ebeneyer, Man. of Geol., 1860)

Munsell notation. A system for designating color by degrees of the three simple variables - hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with a hue of 10YR, a value of 6, and a chroma of 4.

Drainage class (natural). Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have a low available water capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Neutral soil. In practice, a soil having a pH value between 6.6 and 7.3. Strictly speaking, a soil that has a pH value of 7.0.

Organic matter. A general term for plant and animal material, in or on the soil, in all stages of decomposition. Readily decomposed organic matter is often distinguished from the more stable forms that are past the stage of rapid decomposition.

Parent material. Disintegrated and partly weathered rock from which soil has formed.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Percolates slowly. Slow movement of water through the soil adversely affects the specified use.

Permeability. The capacity of rock for transmitting a fluid. Also, the ease with which gases, liquids or plant roots penetrate or pass through a bulk mass of soil or a soil layer.

Phreatophyte. A plant that habitually obtains its required water supply from the zone of saturation, either directly or through the capillary fringe. (Meinzer, USGS WSP 494, p. 55, 1923)

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		pH
Extremely acid.....	Below 4.5	Neutral.....	6.6 to 7.3
Very strongly acid.	4.5 to 5.0	Mildly alkaline.....	7.4 to 7.8
Strongly acid.....	5.1 to 5.5	Moderately alkaline....	7.9 to 8.4
Medium acid.....	5.6 to 6.0	Strongly alkaline.....	8.5 to 9.0
Slightly acid.....	6.1 to 6.5	Very strongly alkaline.	9.1 to higher

Saline-alkali soil. A soil that contains a harmful concentration of salts and exchangeable sodium; or contains harmful salts and has a highly alkaline reaction; or contains harmful salts and exchangeable sodium and is strongly alkaline in reaction. The salts, exchangeable sodium, and alkaline reaction occur in the soil in such locations that growth of most crop plants is less than normal.

Saline soil. A soil that contains soluble salts in amounts that impair growth of plants but that does not contain excess exchangeable sodium.

Sand. Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Sedimentary rock. A rock composed of particles deposited from suspension in water. The chief sedimentary rocks are conglomerate, from gravel; sandstone, from sand; shale, from clay; and limestone, from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sands have been consolidated into sandstone.

Silica. Silica is a combination of silicon and oxygen. The mineral form is called quartz.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Slope, soil. Percent slope gradient and adjectives used are:

Nearly level.....	0 to 2 percent
Gently sloping.....	2 to 4 percent
Moderately sloping.....	4 to 8 percent
Strongly sloping.....	8 to 15 percent

Moderately steep..... 15 to 30 percent
Steep..... 30 to 50 percent
Very steep..... more than 50 percent

Soil association. A soil association is made up of adjacent soils that occur as areas large enough to be shown individually on the soil map but that are shown as one unit because the time and effort of delineating them separately cannot be justified. There is a considerable degree of uniformity in pattern and relative extent of the dominant soils, but the soils may differ greatly one from another. The name of an association consists of the names of the dominant soils joined by a hyphen. Riodit-Alpha association is an example.

Soil series. The series is a group of soils that formed from a particular kind of parent material and have horizons that, except for texture of the surface layer, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineralogical and chemical composition. Soil series are named for a geographic location near the place where the series was first observed and mapped.

Soil variant. A soil having properties sufficiently different from those other known soils to suggest establishing a new soil series, but a soil of such limited known area that creation of a new series is not believed to be justified.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are - platy (laminated), prismatic (vertical axis of aggregates longer than horizontal), columnar (prisms with rounded tops), blocky (angular or subangular), and granular. Structureless soils are either single grained (each grain by itself, as in dune sand), or massive (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Surface layer. A term used in nontechnical soil descriptions for one or more layers above the subsoil. Includes A horizon and part of B horizon; has no depth limit.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Upland (geology). Land consisting of material unworked by water in recent geologic time and lying, in general, at a higher elevation than the alluvial plain or stream terrace. Land above the lowlands along rivers.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

CHAPTER 6.0

BIBLIOGRAPHY

- Barth, R. C. and B. K. Martin. 1982. Soil-depth requirements to reclaim surface-mined areas in the Northern Great Plains. CO School of Mines Rep. on U.S. Bur. Mines. C/N J0265025. Golden.
- Buol, S. W., F. D. Hole and R. J. McCracken. 1973. Soil Genesis and Classification. Iowas State University Press. Ames, Iowa.
- Coenenberg, J. G. 1982. Methods for establishment of diverse native plant communities at the Rosebud Mine. pp. B-6:1-20 In: F. F. Munshower and S. R. Fisher (co-chairman) Mining and Reclamation of Coal Mined Lands in the Northern Great Plains. Symposium held at Billings, MT (March 8-9, 1982). Reclamation Res. Unit. MT St. Univ., Bozeman.
- Gould, W. L. 1978. Approach to reclamation of surface-mined land in the Fruitland Formation in New Mexico. pp. 850-858. In: M. K. Wali (ed.). Energy and Coal Resource Development - volume 2. Pergamon Press, New York.
- King, L. A. 1980. Effects of topsoiling and other reclamation practices on nonseeded species establishment on surface mined land at Colstrip, Montana. Unpub. M. S. Thesis. MT State Univ. Bozeman. 128 p.
- Parton, W. J., J. E. Ellis, and D. M. Swift. 1978. The impacts of stripmine reclamation practices: a simulation study. pp. 584-591. In: M. K. Wali (ed.). Energy and Coal Resource Development - volume 2. Pergamon Press. New York.
- Power, J. F. 1978. Reclamation research on strip-mined land in dry regions. pp. 521-535. In: F. W. Schaller and P. Sutton (eds.). Reclamation of Drastically Disturbed Lands. Am. Soc. Agron. Crop. Sci. Soc. Am., and Soil Sci. Soc. Am. Madison, WI.
- Schafer, W. M. 1980. New Soils on Reclaimed Land in the Northern Great Plains. pp. 13:1-10. In: Adequate Reclamation of Mined Lands? - A Symposium. Am. Soil Cons. Soc. and Western Agr. Exp. Sta. Coordinating Committee on Mine Waste Reclamation.
- Schuman, G. E. and J. F. Power. 1980. Plant growth as affected by topsoil depth and quality on mined lands. pp. 6:1-9. In: Adequate Reclamation of Mined Lands? - A Symposium. Am. Soil Cons. Soc. and Western Agr. Exp. Sta. Coordinating Committee on Mi Mine Waste Reclamation.
- Soil and Land Use Technology, Inc. 1980. Soils of the Antelope Valley-Roberts Mountain Area, Eureka and Lander Counties, Nevada. Vol. I. Order 3 Soil Inventory in the BLM Battle Mountain District.

Soil Conservation Service (SCS), Archer. 1980. Soil Survey of Diamond Valley Area - Parts of Eureka, Elko and White Pine Counties, Nevada. U.S. Dept. of Agriculture, Soil Conservation Service and U.S. Dept. of the Interior, Bureau of Land Management in cooperation with Univ. of Nevada Agricultural Experiment Station.

Schafer, W. M. 1980. New Soils on Reclaimed Land in the Northern Great Plains. pp. 13: 1-10 In: Adequate Reclamation of Mined Lands? - A Symposium. Am. Soil Cons. Soc. and Western Agr. Exp. Sta. Coordinating Committee on Mine Waste Reclamation.

BLM Library
D-553A, Building 50
Denver Federal Center
P. O. Box 25047
Denver, CO 80225-0047

Form 1279-3
(June 1984)

BORROWER

TD 195 .M3 M6
Soil resource
molybdenum p

DATE
LOANED

BORROWER

USDI - ELM

BLM Library
D-553A, Building 50
Denver Federal Center
P. O. Box 25047
Denver, CO 80225-0047

